FORECASTING SYSTEMS USING THE LABORATORY AND EPIDEMIOLOGY TO PREVENT OUTBREAKS OF EXISTING AND EMERGING DISEASES

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Summary: Recent experience shows that infectious animal diseases are increasing in importance worldwide and that disease emergencies are occurring with increasing frequency. Even industrialised nations have been affected. For example, outbreaks of classical swine fever in Germany and the Netherlands in the past two years have cost in excess of $2 billion to control. The epidemic of bovine spongiform encephalopathy (BSE) in the United Kingdom (UK) has caused not only a world-wide ban of beef export from the UK but also a fundamental rethinking of public health and animal feeding practices. In the past three years, there have been foot and mouth disease (FMD) emergencies in south-eastern Europe, South-East Asia and Africa; rinderpest in East Africa, the Near East and southern Asia; contagious bovine pleuropneumonia in East, southern and West Africa; classical swine fever in the Caribbean; African swine fever in southern and West Africa. This year a major epidemic of Rift Valley fever and other insect-transmitted diseases have affected or threatened several countries in East Africa.

Besides their economic significance in terms of production losses, these epidemics have disrupted international trade. A questionnaire was designed to poll OIE Member Countries in order to gauge their capacity for disease forecasting. The questionnaire revealed a wide disparity among Member Countries in the flow of disease information from farm to national headquarters. For notifiable diseases information seems to take up to a week to reach headquarters for most countries, except in Europe where disease notification was reported as taking less than a day.

Computer-supported quantitative epidemiology, including risk analysis, disease modelling, GIS³-based disease mapping, decision support systems and disease forecasting, emerged as an area of deficiency in most national veterinary planning. A hierarchical system for a global early warning system against epidemic diseases is therefore proposed. FAO, through the EMPRES programme, has started to embark on such a concept to be developed in close collaboration with the OIE and other organisations. It is also apparent that a prerequisite for an efficient global early warning system is the capacity, at the national level, to collect data in a harmonised manner and to process such data. Regional organisations, OIE and FAO Commissions and international agencies can help the national veterinary authorities of Member Countries to develop their capacity in these disciplines. It is also proposed that national veterinary authorities should incorporate concepts of emergency preparedness at an early stage in their plans for progressive control programmes for infectious diseases.

1. INTRODUCTION

The second half of the 20th century has witnessed rapid growth in all aspects of communication. In terms of transport, the movement of people and goods to virtually any part of the world is now only a matter of hours. Developments in technology information through telecommunication, satellite and computer technologies are rapidly bringing the concept of a global village closer to reality. This period has also seen an increasing awareness of mutual dependence, which should translate, hopefully, to mutual enhancement. It is fitting, therefore, that as we approach the end of the century, we should have witnessed the birth of the WTO⁴ as a result of the GATT⁵ and the development of the Sanitary and Phytosanitary (SPS) Agreement.

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¹ Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases
² Food and Agriculture Organization of the United Nations
³ Geographic Information Systems
⁴ World Trade Organization
⁵ General Agreement on Tariffs and Trade
The cornerstone of the GATT Agreement is the promotion of international trade through the removal or at least reduction of inappropriate restrictive practices. Thus, livestock and animal products have increasingly become world trade commodities. Evidently, unregulated trade in these commodities could result in wide scale dissemination of animal diseases with consequential disastrous economic losses for the farming communities of importing countries. However, the old protection of hiding behind the so-called zero-risk concept is no longer scientifically justifiable. The WTO has mandated the OIE with the task of providing scientific guidance for animal health practices governing international trade (6). This has consolidated the role of the OIE as the main international animal health organisation responsible for international reporting of animal diseases with trade implications.

2. THE INFECTIOUS DISEASE MENACE

In recent years infectious diseases have become of increasing global concern, far more than could have been predicted in the 1970s when it was assumed that their significance would be confined to developing countries (13). For example, there have been epidemics of old diseases, such as the rinderpest epidemic of the 1980s, which affected most of tropical Africa, the Middle East and South Asia (14, 37, 38, 41). The recent epidemic of classical swine fever (hog cholera) in Germany, the Netherlands and Spain might also be considered to be due to an old disease, the economic impact having been exacerbated by new agricultural practices. While in Germany and the Netherlands the control costs for this disease are in excess of $2 billion, the disease is known to be widespread in other parts of the world (13, 35), and its impact on low income farmers in Haiti, the Dominican Republic, the Philippines and Cuba, for example, is no less dramatic in relative terms than that in the Netherlands.

African swine fever has recently (1996-1998) caused heavy losses in Côte d’Ivoire, Benin, Togo, Nigeria and Cape Verde. Côte d’Ivoire and Benin have lost about 100,000 and 300,000 pigs, respectively (i.e. approximately 25% of population), due to the epidemics. This has resulted in a major setback for a food security programme aimed at increasing the protein supply from short-cycle livestock. The dramatic effects of the foot and mouth disease (FMD) epidemic in Taipei China are well known (8, 43), but the same virus biotype had caused high losses in the pig industry of parts of the Philippines, Hong Kong and Vietnam.

Porcine reproductive and respiratory syndrome (PRRS) represents a group of diseases that have been relatively recently recognised and which are evolving (26, 36). This disease threatens productivity in the Americas and Europe. Its apparently recent introduction/recognition in parts of eastern Asia (18) is a serious concern to this region, especially as these countries also face the threat of the pig-adapted FMD virus type 0.

The paramyxovirus infection, which precipitated the deaths of 13 horses and one person in Australia, stunned the world in terms of its sudden manifestation and potential hazard. Paramyxoviruses and the related morbilliviruses have recently become prominent as either new or evolving diseases, for example those of sea lions, seals, and dolphins and, recently, canine distemper in the lion population of the Serengeti in northern Tanzania (4, 5).

In East Africa, a major consequence of the most recent El Niño event has been the flooding and associated upsurge of mosquito and other insect populations. This resulted in an epidemic of Rift Valley fever causing widespread illnesses and deaths in humans and extensive abortions among small ruminants and camels, especially in Kenya, southern Somalia and northern Tanzania. An examination of the satellite remote sensing images for the Normalised Difference of Vegetation Index (NDVI) during the months of November-December 1997 and January-February 1998 showed that using the system described by Linthicum et al. (24), areas for intensive surveillance for Rift Valley fever (RVF), and other vector-borne diseases, could readily be identified. This was particularly so when the NDVI data were taken as the difference between values during 'normal' months and during the period either immediately preceding or during an RVF epidemic.

Thiermann (1996) has argued that livestock and animal products have become a highly diversified trade commodity so much so that a single carcass can end up in several parts of the world as different segments are sold to different markets and for different needs – a potent disease dissemination factor. With processed animal products becoming of increasing importance in food supply, food poisoning has become of increasing concern. The new disease of greatest impact, has been bovine spongiform encephalopathy (BSE), especially following its implication in the new variant form of Creutzfeldt-Jakob disease, although since it was first recognised in 1986 up to the end of 1997 there have only been a total of 172,998 confirmed cases (31, 34, 48).

It is therefore not surprising that, when faced with the dilemma of the desire for increased and liberalised trade on the one hand and the threat of infectious diseases on the other, the World Food Summit in Rome in 1996 committed the world governments and the civil society to:

«Seek to ensure effective prevention and progressive control of plant and animal pests and diseases,
including especially those which are of transboundary nature, such as rinderpest, cattle tick, foot and mouth disease and desert locust, where outbreaks can cause major food shortages, destabilise markets and trigger trade measures; and promote concurrently, regional collaboration in plant pests and animal disease control and the widespread development and use of integrated pest management practices» (15).

An international system for detecting and forecasting the evolution of disease outbreaks would be a major step in fulfilling the global commitment for effective prevention of epidemic diseases.

3. THE OIE RESPONSE TO THE CHALLENGE OF INFECTIOUS DISEASES

As already noted, the WTO has mandated the OIE with responsibility for scientific advice on matters of international trade in animals and animal products. Thus, the International Animal Health Code (the Code, 33) has had to be strengthened to reflect a scientific basis for determining animal disease freedom by countries or zones therein. Evidently this complements the Codex Alimentarius, which defines food standards. Progressively, the Code has been updated to include surveillance standards for key diseases and criteria for definition and verification of either freedom from disease or infection. The OIE has also strengthened its Manual of Standards for Diagnostic Tests and Vaccines (the Manual, 32), which, like the Code, is periodically updated and internationally agreed. The Manual provides the scientific and technical background for the provisions of the Code. It is the major international harmonising text for diagnosis of the most important transmissible animal diseases.

In recent years, the OIE has sought to focus the international animal health community on three themes, namely (i) surveillance, (ii) quality assurance of national Veterinary Services, and (iii) risk assessment, analysis and management. These themes have featured either as special technical subjects for the General Session or as dedicated issues of the OIE Scientific and Technical Review (27, 30). They are also progressively being incorporated into the Code.

A basic mandate of the OIE is the international exchange of information on disease occurrence. The categorisation of infectious diseases into List A and B reflects, fundamentally, the different requirements for prompt international reporting. Thus, for List A diseases, which are defined by the Code as «transmissible diseases which have the potential for very serious and rapid spread, irrespective of national border», it is necessary to report to the OIE soon and as often as possible. To facilitate this international disease information exchange, the OIE, in collaboration with other organisations, has recently updated the format of the FAO/OIE/WHO® annual questionnaire on animal health, promoted specific computer softwares (e.g. HandiSTATUS®), and begun to issue weekly the Disease Information bulletin not only in paper but also on the internet.

Fundamental to the OIE Information System is the notification of disease occurrence data by the Chief Veterinary Officer of each Member Country. Accordingly, the quality of disease information disseminated by the OIE reflects the quality of information that its Central Bureau receives from Member Countries. Is such information appropriate or adequate for disease forecasting at the national or international levels? To what extent should the OIE, alone or in collaboration with other international organisations, become involved in disease forecasting? To address these issues a questionnaire was distributed to 145 OIE Member Countries. The present report details the response to the questionnaire.

4. RESULTS FROM THE QUESTIONNAIRE

The questionnaire was designed to avoid responses with extensive explanations. It had to build on the previous themes of surveillance, quality assurance of national Veterinary Services and risk assessment. The questionnaire also had to reflect the practices of Member Countries in the five principal components of epidemiology delivery systems described by Hueston (22), i.e. trained field force, diagnostic laboratory support, data collection and analysis, telecommunication for transmitting and receiving surveillance data, and the legal authority for animal disease regulation. A total of 11 topics were covered. Replies were received from a total of 79 of the 145 OIE Member Countries.

4.1. Responses concerning data gathering and analysis

Overall, Delegates considered their countries to have a high capability for data gathering and studying trends in
livestock diseases, especially emerging or exotic diseases. On average the frequency of data arrival at the national headquarters was monthly. However, when the returns were broken down by region, it became apparent that the American and European regions scored highest while Africa, Asia and the Middle East had lower scores. Nevertheless, all the regions had a strong desire for further improvement or development of their capacity for studying disease trends.

The sections dealing with data gathering to determine disease trends demonstrated that monitoring of veterinary medicines sale and the use of sentinels were not greatly used as only 50% of the returns were affirmative. Furthermore, the majority of the affirmative returns for sentinel herds/flocks related to highly specific objectives, such as restocking after disease eradication.

Most of the 79 returns (85%) claimed to operate targeted clinical or serological surveillance as part of their national early warning against three or more diseases considered to be exotic.

The use of geographical and livestock density data for disease forecasting seems to be relatively rare for the 80 Member Countries that responded to questions on this aspect. Only 7.5% (6 countries) considered themselves to have extensive capability and only 5% used such data on a monthly basis. Over 60% (50 countries) considered themselves to have a low capacity to use these analyses. Furthermore, a similar percentage (68%) assessed their national Veterinary Service to have little confidence in such studies. Nevertheless, 84% expressed a desire for development of such systems.

4.2. Responses on disease notification

The efficiency of any early warning system is dependent on the rapidity of notification. On the whole, most returns considered their countries to have rapid systems for disease notification from the farm level to the national veterinary headquarters. Only 11 countries (14%) stated that notification would take a week or more to reach the headquarters. The European region seems to have the most rapid system as all returns from Europe considered that such notification would take less than one day to reach the headquarters. In response to self-assessment of the effectiveness of national surveillance, the African region had the lowest median score (3 on a scale of 5).

Special surveillance networks for non-livestock diseases (bees, aquatic animals, wildlife, etc) exist in about 60% of the countries that responded. In all but 2 of the 49 countries with such networks, there is a requirement for the networks to report the appearance of a new disease. Similarly, there seems to be a high (89%) proportion of countries in which private practitioners are required to report to the official Veterinary Service cases suspicious of a new disease. Only 9 out of the 79 returns (2 from Africa, 3 from Europe and 4 from Asia) seem to lack such legal powers.

4.3. Responses on laboratory support to disease forecasting

Most returns indicated that laboratories have adequate facilities for routine diagnosis and use standard reagents. However, in general, these facilities were judged to be modest with respect to competence. Furthermore, only about half (56%) of the responding countries had national proficiency testing programmes for the laboratories. The use of standard reagents was predominantly in support of national disease eradication programmes (89%), differential diagnosis (80%) and import/export testing (80%).

Of the 79 responses on reference laboratories, 76 (97%) used recognised (FAO, OIE, WHO, etc.) Reference Laboratories. The highest rated needs for these laboratories were confirmatory diagnosis, characterisation of pathogens and diagnosis of suspected exotic or emerging diseases. The lowest rated need was for primary, routine diagnosis.

The African and Middle Eastern Regions were the most lacking in resources for undertaking the characterisation of disease agents. Returns from these regions indicated that 68% and 56%, respectively, had poor or no resource for such activity, in contrast with 21% – 34% for the Asian, American and European Regions.

4.4. Responses on risk assessment

Risk assessment seems to be a discipline that has not yet been assimilated into the routine programmes of most
national veterinary authorities. There was a moderate score (median=3 on the scale of 5) in the 4 parameters asked: national capability, frequency of application, confidence/competence and the desire for improvement or development. Only 6 countries (7.6%) claimed to have extensive capability to perform risk assessments. In all, 24 countries (30.4%) considered themselves to have nil to very low national capability and to seldom use risk assessment. The regional distribution was: African Region 11 out of 22 returns (50%); Middle Eastern Region 4 out of 9 returns (44%); Asia and Pacific 5 out of 14 (36%); Americas 2 out of 11 (18%) and Europe 3 out of 28 (11%) (NB: some countries belong to more than one Region).

International collaboration in risk assessment seems to be predominantly associated with commodity trading. Accordingly 50% - 60% of the returns confirmed the involvement of national veterinary authorities with importing/exporting countries or third parties in risk assessment in association with international trade. Other aspects of international collaboration cited were the following:

- Joint risk analyses in support of regional export of a special commodity, for example ostrich exports from some SADC8 countries to the EU9;
- A regional organisation undertaking risk analysis on behalf of the members, for example that by the Commission of the European Union for imports into EU Member States (cited by France and the United Kingdom or RIOPPAH10 for Central America (cited by Costa Rica);
- Cross-border disease eradication programmes – surprisingly sited by only two countries;
- Research and development of methodologies.

The relationship between national Veterinary Services and those of neighbouring countries or with the medical services is a factor in assessing the quality of Veterinary Services as well as in risk assessment. Only 4 countries indicated having poor to nil contact with the Veterinary Services of neighbouring countries. The formation of regional economic groupings has resulted in national Veterinary Services within such economic communities working closely together on animal health issues. By contrast, the interface with the national medical services, on the whole seems to be limited to specific programmes on zoonoses. Only a few countries referred to a broad-based, policy-planning collaboration between the national Veterinary and Medical Services.

4.5. Responses on the use of computers

The inquiry on enhanced computer usage demonstrated that the application of disease modelling and computer-based decision support systems has not yet gained wide application in the national veterinary programmes for managing disease. Out of 77 returns only 3 countries (3.9%) scored themselves as having extensive capability in disease modelling. There was only a total of 14 countries (18%) that considered themselves to have good expertise (i.e. a score of 4 or 5 on a scale of 5). A total of 40 countries (52%) rated themselves as having either nil or minimal capability.

There were only 12 countries from 78 responses (15.4%) that either had already (10 countries) or were developing (2 countries) computer-assisted decision support systems. Of these, 4 did not describe the system or its use. Two countries reported on the use of HandiSTATUS in risk assessment. One country had a system for assessing the risk of introduction of ticks and tick-borne diseases. Two countries had systems for risk management and commodity tracking. One Member Country had adopted an expert decision support system (EpiMAN11) for disease forecasting and outbreak management. Another country had a similar system for managing foot-and-mouth disease and classical swine fever.

5. DEVELOPING A GLOBAL EARLY WARNING SYSTEM FOR EPIDEMIC DISEASES

5.1. Technical considerations for developing an effective early warning system

The central issue is whether the concept of an early warning system is feasible for animal diseases, particularly...
those of a transboundary nature. The questionnaire aimed at assessing the availability of the principal elements, namely epidemiological data and capability, the role of geographical information systems, livestock farming and data on trade, laboratory diagnosis and molecular characterisation of pathogens, and the computer-based analytical power for epidemiological analysis, risk analysis, modelling, and disease management support.

It is obvious that expert knowledge of the disease, the aetiological agent and the mode of transmission are crucial to the consideration of any form of disease forecasting. The questionnaire has clearly demonstrated that Member Countries regard the role of international Reference Laboratories (OIE, FAO, WHO) as being primarily in confirmatory diagnosis and characterisation of the aetiological agent. Until recently, characterisation was essentially reliant on typing and sub-typing by serological techniques using polyclonal antisera. It should be noted, however, that these techniques are essentially for strain differentiation. They are not tests for identity. Now with the wide application of molecular biology, particularly nucleotide sequencing, there is a tool for identification. It is possible to refer to one virus isolate as being identical to another, at least for a defined genomic segment. This has given rise to what is generally referred to as molecular epidemiology. These techniques have been particularly useful in tracing the origin and spread of outbreaks. Furthermore, when combined with knowledge of animal movement patterns and other epidemiological tools, nucleotide sequence data have contributed immensely to early warning and disease forecasting. For example, work led by the FAO World Reference Laboratory for Rinderpest at Pirbright, has resulted in clustering of all the rinderpest strains into three distinct phylogenetic lineages: two African lineages and one Asian lineage. This has shown that most of the isolates from the Middle East are of the Asian lineage. It has also been possible to demonstrate two different lineages circulating in the same country, as happened in Nigeria during the 1980s and recently in Kenya (17, 47). For example, the identification of African Lineage 2 virus in 1995 in Kenya helped the field investigators and disease control strategists to focus their attention to the north-eastern region of Kenya and southern Somalia rather than southern Sudan, which had been regarded as posing the greatest risk for rinderpest invasion. Furthermore, with such knowledge and building on the local knowledge of animal movement patterns, it was possible to forewarn northern Tanzania accordingly.

The OIE/FAO World Reference Laboratory for FMD now routinely uses nucleotide sequencing data in the characterisation of field isolates. It has been possible to demonstrate confidently that while the three type O outbreaks of FMD in Italy, Bulgaria and Greece could be regarded as Middle Eastern origin, they were from different sources (23). Similarly the type O, pig-adapted isolates from Hong Kong, the Philippines, Moscow and Taipei China were identical. This virus has recently been identified in Vietnam where it seems to co-circulate with a genetically different type O virus (World Reference Laboratory. for FMD, 1997, unpublished data).

Molecular analysis can also lead to prediction of genetic mutations in the virus population. This has been most studied in the influenza virus in which point mutations, recombination and re-assortment are common. Such predictions are used to forecast major epidemics and to prepare new vaccine strains. Technically it may be possible to evolve a similar approach for other viruses with segmented RNA\textsuperscript{12} such as those of the Orbivirus group, such as bluetongue and African horse sickness.

A knowledge of transmission patterns allows for disease modelling. This discipline is a branch of epidemiology that will increasingly play a major role in several aspects of forecasting, including early warning aspects, risk assessment, forecasting the evolution of epidemics and the choice of a cost-effective option for a disease control programme (10, 46). As the questionnaire has shown, disease modelling is an area that is not well developed or used by national Veterinary Services. Yet the increasing demand for risk assessment and analysis for both disease control and international trade will dictate a growing role for this discipline in national or regional veterinary policy planning as is already happening in the medical programmes for infectious diseases. In order to be of practical relevance, disease modelling must apply to real data generated by sound field investigations supported by a competent laboratory service. Such data need to be generated where the disease to be modelled occurs. These aspects are as important as mathematical and computing skills. The dilemma revealed by the questionnaire is that the regions where infectious diseases are most prevalent are the most deficient in the capacity for quantitative epidemiology including modelling.

Foot-and-mouth disease is a good example of how the different systems are contributing to the concept of forecasting. The devastating 1967/68 FMD epidemic in the UK (29) seems to have stimulated three key lines of research, which are still used today, namely, aerobiology in veterinary medicine, survival of the agent in the body and animal products, and the molecular genetic character of the virus. Thus, the importance of aerosol spread was demonstrated. The amount of airborne virus excreted was shown to depend on virus strain, species of animal and

\textsuperscript{12} Ribonucleic acid
the previous vaccination history. Pigs may excrete up to 30 times more virus than cattle (11, 42). It was also shown that, under temperate climatic conditions, wind-borne dissemination of FMD virus can occur over considerable distances (44). Thus Gloster et al. (19) were able to construct a mathematical model that takes account of virus excretion as an aerosol plume, wind direction and speed, virus emission and conditions that determine virus deposition and survival. The model was used to fit retrospectively to the observed evolution of past outbreaks. Subsequently, Donaldson et al. (12) showed that the model could be used in real time to forecast the spread of FMD and institute appropriate surveillance and prevention or control measures. The Gloster model has been further refined to improve its forecasting capability (9). Wind-borne transmission has been shown to occur with other diseases (e.g. Newcastle disease, Aujeszky’s disease) and similar models have been constructed to forecast the spread. Recently Casal et al. (7) have applied a model originally designed for prediction of the dispersion of chemical atmospheric pollution to simulate the spread of foot-and-mouth disease and Aujeszky’s disease.

The outcome of this broad-based programme is that risk analysis and forecasting for FMD can be based more on sound data than conjecture. It is not surprising that foot-and-mouth disease should have been the target for the first integrated computer-based, decision support system for managing epidemics. Thus, EpiMAN, the system originally developed in New Zealand (37, 39, 40) has been intensively studied for adoption in Europe (25) and is being evaluated in other geographical areas and for other infectious diseases (28). This system was illustrated at the 65th General Session of the OIE in 1997 by its inventors, Professor Morris and Dr Sanson of New Zealand.

EpiMAN with a modular configuration comprising sub-sets for GIS, livestock demography, meteorological data, other databases, and expert epidemiological tools for the disease in question has yet to be widely adopted by Member Countries. Nevertheless, this development points the direction for national Veterinary Services of the near future. Apart from expert knowledge of the biological and genetic characteristics of the pathogens and the specific epidemiology of the disease, EpiMAN and/or similar systems will demand of national Veterinary Services four new operational set-ups:

- a dedicated epidemiological unit with disease mapping capability;
- the availability of national digitised land use maps;
- the generation and availability of livestock identification and demographic data;
- a veterinary organisational structure that is consciously set up to be responsive to disciplines designed in the computer system.

Meanwhile, the OIE, FAO, and other international or regional organisations should encourage the concept of harmonised systems for data collection. PC-based software that can be readily adopted, even by developing countries, are becoming available. These include HandiSTATUS (OIE-FAO-IICA13), the SID14 system used in rinderpest sero-monitoring programmes (FAO/IAEA15), and disease tracking systems, such as the Di-Tracker (an FAO system under field-testing).

The recent cycles of Rift Valley fever in Africa have highlighted the need for an effective early warning system that can warn national veterinary authorities to set in motion appropriate vector control and immunisation programmes. As already pointed out, remote sensing satellite imagery can play a critical role in forecasting the likely epidemics of Rift Valley fever. Figure 1 illustrates how such a system would function. It should be noted that remote sensing satellite imagery has already been extensively used for desert locust early warning to guide ground level surveillance (20, 21). FAO, which already houses some of the necessary data that support crop forecast and desert locust early warning seems to possess the necessary template for such an epidemic disease early warning system.

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13 Inter-American Institute for Cooperation on Agriculture
14 Serum Intervention Data
15 International Atomic Energy Agency
5.2. The strategic issues at the international/global level

Both the OIE and FAO have increasingly been involved in epidemic disease emergencies, collaborating with Member Countries in response to such emergencies. Since 1994, FAO has started to address the issue of emergency prevention. The FAO Emergency Prevention System (EMPRES) programme for transboundary animal diseases collaborates with the OIE on a wide scale. One of the areas that EMPRES is committed to undertake is to collaborate with the OIE, regional organisations and Member Countries to develop a Global Early Warning System (GEWS) for Transboundary Animal Diseases. The main task of the EMPRES Global Early Warning System is to develop and implement a workable real-time information network among FAO Member Countries, and regional and international agencies concerned with the control/eradication of major transboundary animal diseases. EMPRES-GEWS also assists FAO Member Countries to adopt the principles of early warning, effective disease control responses and soundly designed progressive control programmes based on active disease surveillance, good reporting systems, epidemiological analysis and close collaboration with FAO, OIE or WHO Reference Laboratories and Collaborating centres.

(a) Inter-Tropical Convergence Zone
(b) Regional Seismic Test Network EG
(c) National Atmospheric and Oceanic Administration/refers to high resolution satellite data
(d) Normalised Difference Vegetation Index

Figure 1: A flowchart illustrating the steps involved in prediction of epidemics of Rift Valley fever and need for prophylactic measures
This system will focus on:

- verifying and validating information generated at the country level and assisting countries to identify and investigate rumours and suspect cases,
- identifying spatial and temporal disease patterns of significance,
- warning countries of, and facilitating rapid co-ordinated responses to, potential adverse developments that present a significant risk of spread of priority diseases,
- supporting and developing innovative approaches to surveillance and information systems from the village level up,
- presenting the global picture of the actual and potential spread of priority diseases following collation, analysis and presentation of data collected at the national and regional levels.

For endemic diseases, particularly the haemoparasitic diseases and their vectors, FAO is already collaborating with the WHO in developing disease risk analysis maps for tsetse fly infestations and their control within farming systems. This takes into account climate, vegetation, land use and livestock as well as human population density.

5.3. The strategic issues at the regional level

It was apparent from the response to the questionnaire that countries within regional economic groupings are progressively collaborating in risk assessment and management as well as in veterinary policy. In 1993, Member Countries of the FAO European Commission for the Control of FMD made an in-depth review of the functions of the Commission, after nearly 40 years of its existence and the eradication of FMD from Europe. One of the key conclusions was that the Commission should concentrate on promoting FMD surveillance, early warning and emergency preparedness. Also in their evaluation of the EpiMAN programme, the Commission of the European Union wished to see the system further developed to be able to function throughout the Union, in conjunction with the Union system for contingency planning.

In 1997, FAO convened an expert consultation on EMPRES (16). Apart from re-endorsing the importance of early warning, this consultation asserted the crucial need for Member Countries, within a geo-political or economic region, to work closely in developing a regionally based, early warning system against epidemic diseases. The objective at the regional level was conceived to include:

- assisting in developing national capacity for early warning and emergency response capability in the countries in the region,
- defining the problems that present the greatest risk within countries of the region and creating clusters of those sharing the same problems,
- establishing a training capacity for the national implementation of early warning systems, emergency responses and contingency plans in the region,
- assessing the national capability (institutional and technical) and requirements for laboratory diagnosis and serology, and field tests for transboundary animal diseases,
- monitoring and co-ordinating efforts to record all livestock movements between countries in the region,
- networking all relevant epidemiological information from the national epidemiologists, and developing predictive models.

The Pan-American Foot and Mouth Disease Centre (Panaftosa) is an example of a regional organisation that has consistently developed such principles at the regional level during the 47 years of its existence. Panaftosa has been central to the successful programmes of FMD eradication in South America, which now constitute the Hemispheric Plan for the Eradication of FMD from the Americas by the year 2009. This plan has been endorsed by the political authorities of the Americas through the Brasilia Declaration in July 1996 (1). Throughout its existence, Panaftosa has played an innovative role in disease information and FMD epidemiology at the regional level. For example, Panaftosa introduced a system for recording disease incidence by geographical co-ordinates long before the involvement of GIS in veterinary epidemiology. Furthermore, Panaftosa was able to classify the occurrence of FMD in South America into primary endemic, para-endemic and epidemic zones. By combining this with knowledge of livestock movement, Panaftosa often could predict the evolution of FMD outbreaks in South America and thereby advise on appropriate vaccination and control measures (2, 3).

5.4. The strategic issues at the national level
Ultimately early warning and disease forecasting must be most effective at the national level. In this regard, the EMPRES expert consultation strongly recommended that emergency preparedness and contingency planning should be an integral part of disease control planning from the inception of any disease control programme. Inevitably such a thrust will lead to a progressive focus by Member Countries on surveillance, early warning, disease forecasting and risk assessment.

Member Countries have demonstrated, through their response to the questionnaire, a strong desire for development or improvement in their capacity for all aspects of the components necessary for building up effective disease forecasting systems. There is, therefore, a strong need for targeted continuing education programmes for senior animal health programme managers. It should be noted that some of the OIE or FAO or WHO Collaborating Centres have already started to provide such a service. For example, the OIE/WHO/FAO Collaborating Centre for Epidemiology at Teramo, Italy, has produced a training guide for practical epidemiology and surveillance. The FAO Collaborating Centres on Emergency Preparedness against Transboundary Animal Diseases at Plum Island (USA), Onderstepoort (South Africa) and Geelong (Australia) have started running practical courses on the recognition and control of tropical epizootics. These Centres have also produced information videos on tropical epizootics or exotic diseases, the most comprehensive of which is probably from the Geelong Laboratory. Furthermore, the Joint FAO/IAEA Division has been championing the rapid dissemination of standardised and quality assurance proven test procedures in developing countries.

In-situ quantitative epidemiology, and hence the inherent capacity for forecasting, is still relatively weak in many Member Countries, especially developing countries. Several universities provide postgraduate programmes in quantitative epidemiology including disease modelling. An exciting initiative is the programme that is jointly organised in the Netherlands by Massey University of New Zealand and Wageningen Agricultural University. The uniqueness of the programme is that it draws on an international panel of experts to train animal health managers from different parts of the world (10).

A related initiative is the FAO-IFAD project, known by the acronym RADISCON, which seeks to build national capacity in disease surveillance as part of the early warning process through the EMPRES programme. The project operates in 29 countries of the Middle East, North Africa, the Horn of Africa and Sahelian countries. The national Veterinary Services of these countries are being connected by e-mail. It is expected that this system will improve the rapid and informal exchange of disease information and thereby enhance the early warning process. It is expected to extend this initiative to include training in GIS and disease mapping. A greater international support is necessary to improve the quality of animal disease data collection and processing at the national level. This, in turn, should improve the potential for disease forecasting as well as the quality of international reporting by all Member Countries of the OIE.

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16 International Fund for Agricultural Development
17 Regional Animal Disease Surveillance and Control Network


