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Current Rinderpest global situation

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1. INTRODUCTION

Rinderpest, also known historically as 'cattle plague', is a serious contagious disease of cattle, Asian buffaloes, yaks and other artiodactyls, both domesticated and wild, including swine, African buffaloes and giraffes. According to Drs Gordon Scott and Alain Provost (1992), it is the most dreaded bovine disease known, belonging to a select group of notorious infectious agents that have changed the course of history. From its known origins around the Caspian Sea, century after century, rinderpest swept west into Europe and east into Asia with every marauding army causing the disaster, death and devastation that preceded the fall of the Roman Empire, the conquest of Christian Europe by Charlemagne, the French Revolution, the impoverishment of Russia and the colonisation of Africa.

The last European outbreaks of rinderpest began in 1917, when the disease crossed the Caucasus entering Ukraine, Latvia and Lithuania in company with the Bolshevik armies and subsequently moved eastwards into Poland in 1920. Following international efforts, that epidemic was finally eliminated in 1923, since when Europe has been free of epidemic rinderpest. Focal outbreaks in Europe, such as those in Belgium in 1920 and Italy in 1949, were introduced by cattle and wildlife imported from India and Somalia, respectively. Interestingly, it was the Belgian incident which led to the only introduction of rinderpest into the Americas. Cattle from Belgium were shipped to Brazil and introduced the disease, although fortunately it was eliminated rapidly. This trade-related outbreak in Belgium was one of the triggers for the founding of the World Organisation for Animal Health (Office International des Epizooties, OIE) in 1924. Elsewhere, the widespread occurrence of rinderpest after the Second World War was in fact one of the major stimuli for the founding of the Food and Agriculture Organization (FAO) in 1945 as a specialised agency of the United Nations. In Asia, FAO demonstrated that intensified vaccination across international borders could be a successful technique in freeing large areas from rinderpest.

During the first half of the 20th century, the consistent application of zoosanitary and prophylactic measures greatly reduced the extent of the disease so that by 1960 it had been eradicated from Europe, China, Russia and the Far East but remained entrenched in the Indian subcontinent and in those African countries immediately south of the Sahara. By 1950, the Inter-African Bureau of Animal Resources (IBAR) of the Organisation of African Unity (OAU) had been created, one of its directives being the elimination of rinderpest from African continent. In the early 1960s, rinderpest in Africa was distributed across the continent in those countries immediately south of the Saharan desert. In 1962, starting with the international coordination of rinderpest vaccination programmes among the countries bordering Lake Chad, a decade-long mass vaccination programme, JP15, was born. Taking a phased approach and moving into different rinderpest affected countries at different times, JP15 set out to vaccinate entire bovine populations in each of three successive years. In totality some 80 million doses of vaccine were delivered to some 30 million cattle. Although JP15 all but succeeded, and certainly eradicated rinderpest from many of the countries involved in the campaign, it neglected to develop the capacity to identify and stamp out residual reservoirs of infection and in the early 1980s a second rinderpest epizootic swept across sub-Saharan Africa undoing most of what had been achieved. Starting in 1986, the resulting Pan African Rinderpest Campaign (PARC) succeeded in reclaiming much of the situation yet it too ended in 1999 without eradicating the virus from Africa. The Pan-African Programme for the Control of Epizootics (PACE) was also mandated to take the credit for the eradication of rinderpest from Africa although the initiative is currently with the Somalia Ecosystem Rinderpest Eradication Coordination Unit (SERECU).

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2. FAO'S PROMOTION OF RINDERPEST ERADICATION

The first international workshop organised by FAO was held at Izatnagar, India, in 1953 under the direction of Dr S. Datta and was concerned with the manufacture of live virus vaccines, particularly rinderpest. Two years later, Dr R. Daubney ran a similar international training workshop in Cairo. This was followed in 1959 by another in Pakistan under the direction of Dr G.G.Alton.

In the 1960s, FAO stimulated the foundation of the Near East Animal Health Institute at several sites. The rinderpest unit was established in Cairo and was equipped to diagnose rinderpest and produce rinderpest tissue culture vaccine.

Although FAO sent an observer to the first international meeting convened for the inauguration of JP15, the organisation's contribution to the early phases of that campaign was slight. When the campaign was extended to eastern Africa, using funds from UNDP, FAO ran training schemes in Ethiopia and Somalia. During the PARC and PACE programmes, FAO maintained a unit in Nairobi for the study of the epidemiology of rinderpest across the African continent. This unit noted the success of the various emergency campaigns against rinderpest in West Africa in the period immediately after the discovery of the second African epizootic.

FAO did much to bring an end to the Near East rinderpest epizootic of 1969-73 but, aware of the need to globalise the drive against rinderpest, an Expert Consultation on Global Strategy for Control and Eradication of Rinderpest was held in February 1987 at FAO Headquarters, Rome, which noted the need for a coordinated campaign against rinderpest in Asia in similar vein to PARC. In the aftermath of the Expert Consultation, SAREC (South Asia Rinderpest Eradication Campaign) and WAREC (West Asia Rinderpest Eradication Campaign) were mooted.

In 1989, in close association with FAO, the so called 'OIE Pathway' was formulated as a process to help rinderpest-infected countries engaged in mass vaccination advance to internationally recognised rinderpest-free status by way of :

- bringing the incidence level to zero;
- ending vaccination;
- undertaking active disease surveillance; and
- using serosurveillance to demonstrate the absence of sub-clinically transmitting infection.

At the 59th OIE General Session in 1991, the International Committee adopted the *Recommended Standards for Epidemiological Surveillance Systems for Rinderpest* proposed by the Foot-and-Mouth Disease and Other Epizootics Commission (now the Scientific Commission for Animal Diseases). These standards drove the Pathway for the next 15 or so years.

In 1994, FAO established the Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases, or EMPRES. FAO's EMPRES-Animal Health programme continues to play a major role in the fight against persisting and/or spreading transboundary animal diseases at a global level, with the emphasis on developing countries where many of these pathogens are endemic. Salient under EMPRES is the Global Rinderpest Eradication Programme (GREP) which has in just a dozen years provided technical assistance and guidance to countries and regions in their rinderpest control and eradication to a point where the Asian and Africa I lineages of rinderpest are extinct and where the African II lineage (the only other lineage) has not been seen in clinical form since 2001.

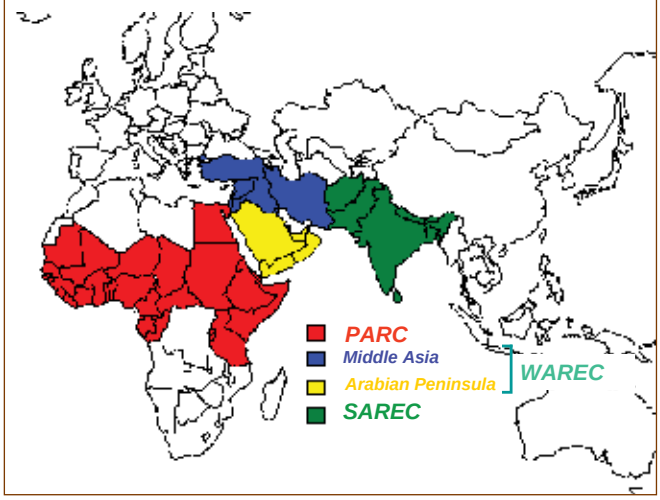
GREP is a time-bound programme which aims to ensure the evidence-based global eradication of rinderpest virus by the year 2010 and counts on the partnership with the OIE, economic blocs or regional specialised organisations, such as the African Union (AU), South Asian Association for Regional Cooperation (SAARC), European Commission, and numerous donor agencies. However, the most important partners of GREP are the countries themselves.

3. PROMOTING VACCINATION

It was originally expected that the EMPRES-GREP would be conducted through a number of coordinated, internationally-assisted regional campaigns mounting mass vaccination programmes as their main thrust against the virus (Fig 1). In reality this did not happen. In Africa, PARC (1986-99), replaced by the wider-encompassing PACE (hosted by AU-IBAR; 2001-06) led much of the field activities of vaccination and surveillance, with key technical assistance provided by EMPRES. A follow-up project, Somalia Ecosystem Rinderpest Eradication Coordination Unit (SERECU, also of AU-IBAR and co-chair by GREP) was developed and funded by the European Commission to focus only on areas of high suspicion of rinderpest in the Somali Ecosystem (SES).

The Western Asia Rinderpest Eradication Campaign (WAREC) operated with UNDP funding from 1989 to 1994, but was disrupted by the first Gulf War and was not resuscitated afterwards. Neither did the expected South Asia Rinderpest Eradication Campaign materialise as an internationally coordinated project, although the EC funded key national projects in South Asia to good effect and promoted local cross-border coordination in the process; EMPRES and GREP were constantly aware of these activities and provided invaluable technical assistance where required. Thus, in the absence of formal coordination, the voids were filled by FAO and other organisations through the GREP Secretariat.

Figure 1. The concept of regional rinderpest vaccination campaigns



4. THE OIE PATHWAY – ENTRY REQUIRES CESSATION OF VACCINATION

Currently, the OIE recognises the status of a country or zone/region for only four diseases: rinderpest, foot-and-mouth disease, contagious bovine pleuropneumonia and bovine spongiform encephalopathy. The OIE [rinderpest] Pathway was developed as a certification process to provide internationally and officially recognised evidence for trading partners that a country is free of rinderpest disease or infection. For the national veterinary authorities it was a tool to guide surveillance activities after cessation of rinderpest vaccination to minimise the risk that foci of infection might remain and possibly spread to unvaccinated populations. The basis is provided in the *Terrestrial Animal Health Code*. It led countries or regions through a step-by-step confidence-building procedure of consecutive declarations (a national declaration of provisional freedom from rinderpest followed by an international declaration of freedom from rinderpest disease) to a final declaration of freedom from rinderpest infection. The certification is based on dossiers of information submitted by a country to the OIE. These dossiers are evaluated by the OIE Scientific Commission for Animal Health which will then recommend that the OIE International Committee (Assembly of OIE Member Countries (Chief Veterinary Officer)) declare that country free of rinderpest disease and consequently free of rinderpest infection.

In addition, the practical implementation of epidemiological surveillance programmes for rinderpest was further developed in a paper commissioned by OIE in 1998. The *Standards* paper states the underlying philosophy by outlining "a system for verifying the steps towards the short and long term aims" (i.e. freedom of countries and freedom of world regions, respectively) and to assist countries which wish to trade in livestock and livestock products, but face difficulties due to the presence or past occurrence of rinderpest. A three-stage process of achieving and proving freedom from rinderpest was envisaged in which once a country is satisfied that it is free from rinderpest and that the disease is unlikely to be reintroduced, the country can declare itself provisionally free from rinderpest provided it is satisfied that it meets fixed criteria. Subsequent steps are then subject to international verification under the auspices of the OIE. At least three years after a country has declared itself provisionally free from rinderpest, a country which meets the criteria may be declared by the OIE to be free from rinderpest disease. At least one year later, a country which meets more stringent criteria with regard to rinderpest may be declared free from rinderpest infection.

Entry onto the Pathway was the hardest procedure for an endemically infected country to adopt because it required abandoning the comfort of repeated vaccinations, even when the incidence level had been brought to zero. This was of course essential because the Pathway would subsequently require active disease surveillance and active serosurveillance in the growing population of susceptible cattle and buffaloes. Data accrued from such surveillance activities would eventually be placed in dossiers for examination by the international authorities. In spite of the perceived high risk situation in which a number of Chief Veterinary Officers placed themselves, on no occasion was there a zoosanitary breakdown following the termination of rinderpest vaccine – which in any case could only take place if there had been no clinical reports for at least 24 consecutive months.

Further, there has been no evidence that in any of the countries previously subject to endemic rinderpest the presence of sub-clinical strains of the virus has been ascertained.

In 1989 when the OIE Pathway was formulated, rinderpest had recently been, or still was, active from India in the east to Turkey to the west, throughout the Arabian Peninsula and in most countries of the Greater Horn of Africa. Mass vaccination was still regarded as the tool for success (which it was – the issue was to know when to stop vaccinating). The situation today, 18 years later and after 14 years of the Global Rinderpest Eradication Programme, is markedly different. Rinderpest in the field in 2007 is very different from what it was conceived to be in 1989; now, gaining a global set of accreditations is technically as demanding as bringing the outbreak incidence level to zero.

The following paragraphs outline the current "Pathway" situation on a regional basis; countries that have already completed the process are not discussed but are represented as rinderpest-free on the accompanying map.

Asia

India's confirmation of rinderpest eradication by eliminating the last reservoirs of infection in Tamil Nadu and Karnataka in the southern peninsula in 1995 was recognised by the OIE. Southeast Asia has undoubtedly been free from rinderpest since the late 1950s (with a possible, but unlikely and unconfirmed, suggestion that it could have persisted in Viet Nam until the 1970s). Elsewhere in Asia, surveillance exercises provide evidence that other reservoirs of infection had also been resolved at about that time. Although Mongolia presented convincing evidence of freedom, there can be little doubt that the Russian Federation is really free from infection but this needs to be officially recognised by the international community. Sporadic rinderpest outbreaks in Georgia SSR (late 1989 continuing into early 1990), Siberia/Mongolia (1991 to 1993) and the Amur region of Russia SSR (1998) can with little doubt be ascribed to reversion to virulence of the vaccine used in an attempt to create an immunised buffer zone on the borders of the former USSR and later the Russian Federation with neighbouring countries.

Central Asia

Under the Italian-funded FAO GTFS/INT/907/ITA[2] project, the beneficiary countries - Afghanistan, Tajikistan, Turkmenistan and Uzbekistan have self-declared pro-

[2] Controlling Transboundary Animal Diseases in Central Asian Countries project. The development objective is to increase food security by reducing livestock production losses caused by infectious disease. The project will contribute to this by enabling national veterinary services to gain a better understanding of disease prevalence and impact in their countries and to plan and implement appropriate control measures. It will contribute to global rinderpest eradication by providing data on which to verify regional freedom from the disease. The project will also provide for technical input into contingency planning and emergency preparedness for outbreaks of transboundary animal diseases.

visional freedom from rinderpest to the OIE and have completed a first round of serosurveillance, the results of which provide reliable information that rinderpest no longer appears to represent a threat for the region. A second round of serosurveillance was carried out in early 2007 and it is foreseen that dossiers seeking accreditation as rinderpest-free may be presented presented before the OIE 2008 General Session.

There is progress throughout the OIE accreditation process in Asia, with only a few countries remaining for international recognition. Pakistan, which is also a beneficiary of GTFS/INT/907/ITA project, has already submitted its dossier to OIE and has been accepted as free from infection (and should be shown in green in Figure 2). The surveillance data presented by these countries, against a background of the complete absence of vaccination for many years, adds confidence to the understanding that the Asian lineage of rinderpest is now extinct.

Africa

In Africa, the OIE Pathway accreditation process has provided assurances in that both West and Central Africa have been free from rinderpest since the last cases occurred on the Burkina Faso/Ghana border in 1988. Northern (except Egypt – although also free but more recently) and Southern Africa have been free for over a century. The possibility that there might have been a later minor introduction from Sudan into the Central African Republic (serological evidence from wildlife) does little to affect this understanding.

Mauritania, which had received recognition from the OIE of freedom from rinderpest disease in May 2003, had that status suspended because two of 32 warthogs were found to be serologically positive during routine surveillance. The two warthogs sampled were 200 km distant from each other. The PACE Epidemiological Unit was active in assisting Mauritania to follow up this situation and show that these results were not indicative of active infection. Following the recommendation of the Scientific Commission of the OIE, Mauritania was once again recognised as free from rinderpest disease in May 2004.

All granted countrywide freedom were engaged in serological surveys to enable proof of freedom from infection. Sierra Leone, Libya, Equatorial Guinea, São Tome and Principe, Cape Verde and Liberia have not yet declared themselves provisionally free. In late 2006, GREP convened a joint meeting of FAO, AU-IBAR and OIE to find ways to facilitate and accelerate the process of accreditation of rinderpest freedom for countries which have yet to make any progress in this direction. The recommendation of that meeting can be found at: http://www.fao.org/ag/againfo/programmes/documents/grep/Joint_FAOGREP_OIE_AUIBAR_Workshop.pdf .

Revisions to the "Pathway"

Based on activities carried out in the Somali Ecosystem and elsewhere around the world, GREP and AU-IBAR requested OIE to re-evaluate the OIE Pathway. In 2007, the adoption of a new *Terrestrial Animal Health Code* Rinderpest Chapter and Annex by the 75th OIE General Session marks the start of the final thrust to achieve global rinderpest freedom accreditation by 2010. Appendix 3.8.2 of the *Code* is available on the OIE and FAO websites. Henceforth countries will be able to apply for freedom from rinderpest either on a historical basis or through a dossier including serosurveillance in a disease-free, unvaccinated population.

5. GREP'S ASSESSMENT OF THE LAST REMAINING FOCI OF RINDERPEST IN THE WORLD

A series of FAO technical and expert consultations held in Rome (FAO 1996, 1998 and 1999) identified six areas of prime concern because of the known or suspected existence of reservoirs of rinderpest virus. These comprised four in Asia (Pakistan with Afghanistan; Asiatic Russia with Mongolia and China; Yemen with Saudi Arabia; and, Turkey with Iraq and Iran - 'The Kurdish Triangle'), and two in Africa (southern Sudan with contiguous areas of Kenya, Ethiopia and Uganda; and southern Somalia with eastern Kenya and southern Ethiopia - the 'Somali pastoral ecosystem – SES') with periodic involvement of southern Kenya and northern Tanzania. This proved to be an accurate assessment and there has been no cause

Figure 2. Status of rinderpest in the world with regard to the OIE Pathway (as of OIE General Session of May 2007)

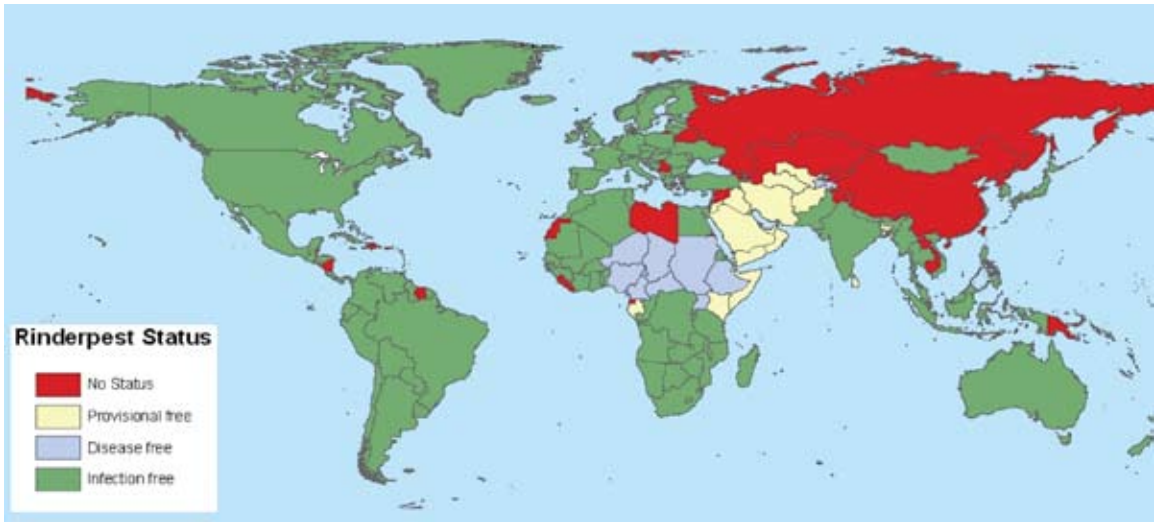
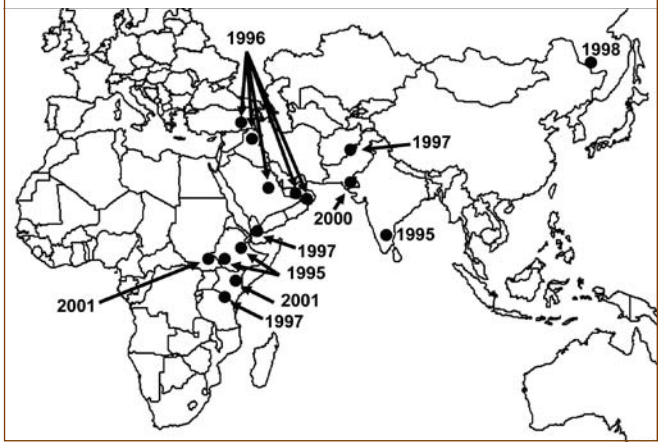


Figure 3. Last rinderpest outbreaks around the world



to suspect the presence of rinderpest outside the areas defined for special attention. Apart from the SES (see below), each of these areas for special attention has now been resolved.

In the Middle East and Central Asia, rinderpest has not been detected (neither disease nor serological evidence of infection) since 2000 where occasional clinical cases were reported in dairy farms near Karachi (Figure 3). Although attributed to livestock movements from Punjab Province, these cases could not be back-traced while subsequent participatory disease surveillance (PDS) indicated that they had probably come from a poorly-reported endemic area along the Indus River buffalo tract of Sindh Province in southern Pakistan. Although there is some evidence from participatory epidemiological studies that the last cases might actually have occurred in early 2001, this is really of little significance since subsequent intensive investigations in Pakistan have continued to confirm the absence of infection, not just disease. Evidence from Afghanistan confirms that the country has remained free since the 1995 incursion of the disease which was eradicated in 1997. The 'Kurdish triangle' (Turkey, Iran and Iraq) experienced its last infection in 1996 and Yemen last detected infection in 1997. Again, formal surveillance data tend to confirm rinderpest absence. Figure 3 shows the area where the last known outbreaks have occurred around the world.

Africa and Somali Ecosystem

Although progress has been made in the eradication of rinderpest by countries in West and Central Africa, the last unresolved focus of serological evidence of infection with rinderpest is in the Somali ecosystem (North-Eastern Kenya, Central and Southern Somalia and Region V of Ethiopia) which has been a subject of considerable attention over recent years.

Rinderpest virus of African lineage 1 persisted in Ethiopia until 1995 (at which time an epidemic extended into the areas today regarded as Eritrea) and in Sudan until 2001. In both countries, extensive serological monitoring of young livestock born after the last applications of vaccines in the region and exhaustive participatory disease search approaches offer convincing evidence of the absence of virus circulation. These were the last strongholds of African Lineage 1 rinderpest virus which has almost certainly joined the Asian Lineage in being consigned to history (though isolates remain for experimental purposes in some laboratory archives around the world).

In 1994, African lineage 2 rinderpest virus was detected in East Africa after an apparent absence of more than 30 years. In 1996, a disease search, based on participatory epidemiological methodologies supplemented by serological and virological analyses, was undertaken in southern Somalia and northeastern Kenya to collate past and current epidemiological information about rinderpest-compatible disease events, and to test the hypothesis that an African lineage 2 rinderpest virus might have persisted in populations of transhumant cattle in the SES.

The findings of these field studies concluded that in southern Somalia and North-eastern Kenya, where herders have an excellent knowledge of the clinical signs of rinderpest, there existed detailed and accurate descriptions of cases and their last occurrence. Herders differentiated between classical acute rinderpest with mortalities approaching 90 percent and a milder syndrome, described in East Africa 50 years earlier, characterised primarily by ocular discharge and diarrhoea, few oral lesions, corneal opacity and occasional mortality. The studies provided evidence for the endemic occurrence of rinderpest, generally mild but periodically increasing in virulence, back to at least 1981, with a periodicity of approximately five years in the case of clinically obvious disease.

Moving forward in time, Lineage 2 rinderpest was last confirmed to be present in October 2001 in buffaloes in Meru National Park of Kenya, a population possibly linked to the SES by migrating cattle. This was unequivocally identified as virus of African Lineage 2 by the World Reference Laboratory for Morbilliviruses (Institute for Animal Health, Pirbright, UK). All subsequent investigations of what might have been a mild form of rinderpest in cattle in Kenya and Somalia (and most recently in a contiguous area of southern Ethiopia in 2004) have failed to provide definitive evidence of rinderpest virus presence whether by virus detection or serology and it is now becoming understood that an alternative aetiology exists which needs to be further investigated. The important conclusion – hopefully of global relevance – is that 2001 was the last time that clinical rinderpest virus was detected in the field anywhere in the world.

Supporting this understanding is the absence of clinical disease from wildlife since 2001 and an inability to demonstrate seroconversion in buffaloes and other wild ungulates for more than five years. The hypothesis that wild African ungulates form an indicator host of rinderpest virus capable of a sustained transmission network of rinderpest virus now has few adherents and it is evident that once the virus is eliminated from cattle herds it dies out in wildlife within three to four years.

Unfortunately, positive serological results obtained in central Somalia are still not fully resolved and are in urgent need of skilled back-tracing; in the meantime the suspicion that rinderpest virus could still be present is impossible to dismiss, even if not supported serologically.

Results of sero-surveys conducted in cattle during the period 2002-03 showed a 4% sero-positivity in cat-

Table 1. Rinderpest sero-prevalence in cattle (%) of three regions of southern Somalia

Region	2002/03	2005	2006 Feb	2006 June
Gedo	17	5.1	-	2.6
Middle Juba	15.99	3.6	2.3	2.9
Lower Juba	16.98	1.6	0.4	1.2

Table 3. Targeted surveys in the Somali Ecosystem

Country	2005		2006	
	N	+ve (%)	n	+ve (%)
Ethiopia			803	2 (0.25%)
Kenya	368	3 (0.81%)	1,972	3 (0.15%)
Somalia	-		2136	13 (0.61%)

Table 2. Serosurveillance results from Ethiopian and Kenyan components of the Somali Ecosystem

Country	2004		2005		2006	
	n	+ve (%)	n	+ve (%)	n	+ve (%)
Ethiopia	1034	27 (2.6%)	2503	2 (0.08%)	6116	4 (0.07%)
Kenya	5073	51 (1%)			3786	0 (0%)

Table 4. Wildlife results in Kenya and Somalia

Country	Total Number of Sera	Kabete cH-ELISA			Muguga - VNT		CIRAD cH-ELISA (RP & PPR)
		-ve	Missing	-ve	*Cont	Missing	
Kenya	312	-ve	2	304	5	3	-ve
Kenya	35	-ve	Nil	35	Nil	Nil	-ve
Somalia	33	-ve	Nil	33	Nil	Nil	Not available
Total	380						

Table 5. Results of wildlife surveillance 2004-06

Country	2004		2005		2006	
	n	+ve (%)	n	+ve (%)	n	+ve (%)
Kenya	150	0 (0%)	-	-	380	0 (0%)
Somalia	-	-	-	-	33	0 (0%)

tle in central Somalia while results on 1 800 sera from Somaliland and Puntland (North Somalia) were all negative for rinderpest antibodies.

Those from areas in southern Somalia are summarised in the Table 1. Three major serological inquests in three regions of southern Somalia (Gedo, Middle Juba, and Lower Juba), conducted over the last four years have shown rinderpest antibody persistence, but incidence levels have decreased over the years. This may be related to the previous vaccination campaign carried out in the area where ageing parameters of the animals to be sampled were not completely accurate (serological surveys should be carried out in the younger populations). In any case, these results are not compatible with the active transmission of the virus.

Similar surveys in Ethiopia and Kenya show no rinderpest antibody persistence (Table 2). In both countries the low proportion of seropositive results for 2005 and 2006 are within the expected range of non-specific results. Accordingly, there is no evidence for virus transmission in either set of results.

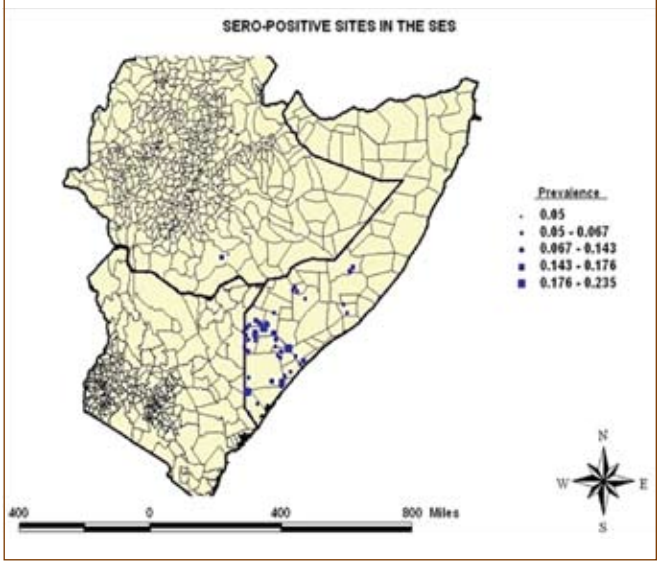
In addition, targeted surveillance was carried out in areas of the SES deemed to be at high risk of sub-clinical rinderpest. The results (Table 3) do not substantiate the attributed risk status.

Virus surveillance

Since 2002, all cases of mild rinderpest-compatible disease reported in the SES have proved negative through laboratory examination of samples; 95 suspected samples have been tested by the immune-capture ELISA test. In Somalia, five samples obtained from kudus and buffalos (in 2002-03) gave negative results. Tables 4 and 5 present the findings of the field investigation carried out in Kenya and Somalia in recent years in wildlife. None of the results are suggestive of the presence of rinderpest virus having affected the populations being sampled.

The distribution of sites within southern Somalia from

Figure 4. Seropositive site in the SES



which rinderpest positive sera were obtained is shown in Figure 4 above.

6. PROBLEMS AFFECTING THE ERADICATION PROCESS

The severe disturbances and civil disruptions in several African countries have not been accompanied by rinderpest epidemics as would have happened during previous decades when the disease was present. Indeed all accruing evidence tends to confirm that the African 1 Lineage of rinderpest virus has been extinct since 2001. Neither has rinderpest featured in recent years in any of the climatic or military emergencies – for example, the Afghanistan, Iraq, Sudan conflicts or drought in the Horn of Africa – which formerly would have led to a resurgence of the disease. There is growing confidence, based on absence of clinical disease in an ever increasingly susceptible, unvaccinated cattle and buffalo population and based on active surveillance studies, that rinderpest has been eliminated from Asia and the Arabian Peninsula. There also exists convincing evidence that rinderpest disappeared from West and Central Africa after the last outbreak in 1988 in Burkina Fasso/Ghana and that African Lineage 1 was eradicated from its last stronghold in southern Sudan in 2001.

Others factors that may hamper eradication are 1) in many countries (African and Asian), some of the systems of husbandry is pastoralist and nomadic in nature and this prevents effective movement control of livestock, and 2) national borders are "permeable" and it is impossible to conduct trace-back activities, especially where civil unrest represents a danger to animal health workers.

Following strong FAO/EMPRES-GREP and OIE recommendations, all official rinderpest vaccination has now ceased and a call is being made for the sequestration of virus for vaccine production and for research be limited to laboratories where compliance with international biosecurity and biosafety standards can be guaranteed.

7. THE CONTRIBUTION OF PARTICIPATORY EPIDEMIOLOGY TO RINDERPEST SURVEILLANCE

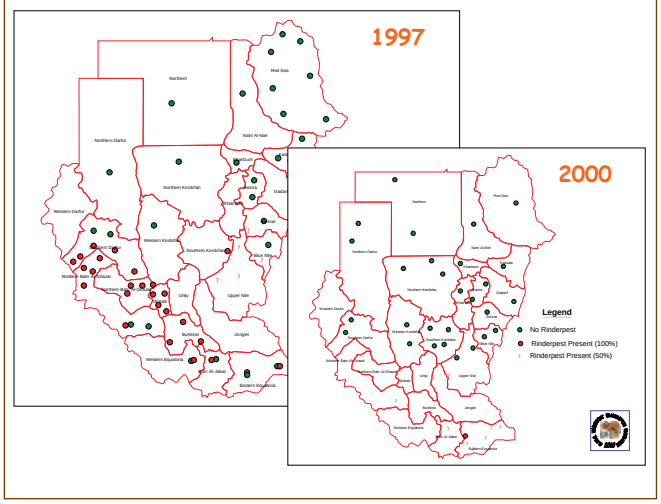
The GREP Secretariat has been involved in assisting certain key countries to resolve their rinderpest status and obtain international recognition with the OIE. Participatory disease search techniques have been essential for the control of rinderpest, for providing the epidemiological understanding of disease maintenance, and for gaining assurance of the disappearance or eradication of the disease. The participatory disease search begins with collection of background data on a community from secondary empirical sources. Just as with general disease surveys, available literature and key informants are utilised to obtain an overview of the community and its priority concerns. Community decision-making structures, herding group organisations and interview strategies need to be identified. Participatory epidemiology and community-based service delivery systems have developed considerably in recent years and have made a major contribution to rinderpest eradication and animal health delivery systems.

Simple but effective participatory tools were used to map rinderpest in the lead-up to the final eradication thrust in Sudan. Figure 5 depicts the results of two mapping exercises conducted by field veterinarians trained in the socio-anthropological approaches that underline participatory techniques in animal health. Hard and 'soft' data on rinderpest occurrence were plotted on two occasions three years apart indicating clearly that progress in disease control had been made and identifying areas of concern.

In southern Somalia, participatory disease search (PDS) detected clinically the syndrome of mild rinderpest (Elser or Shifow) in several locations, but on collection of samples from affected animals these were shown to be negative after laboratory testing.

Similarly in Pakistan**,** in 2000, a reappraisal by veterinarians using PDS provided both cattle/buffalo demographic and disease incidence data to indicate that rinderpest had been and still was endemic in the Indus River Buffalo Tract of Sindh Province. Elsewhere it was discovered that rather than being endemic, periodic epidemics occurred as extensions from the endemic focus.

Figure 5. Participatory disease search (surveillance) findings in Sudan



The situation in Afghanistan was clearly the same as but epidemiologically dependent on the situation in neighbouring Pakistan.

Possible role of rinderpest on bioterrorism

The Biological Weapons Convention (BWC; formally titled the Convention on the Prohibition of the Development, Production, and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction) is the first agreement among nations that declared an entire category of weapons to be off limits. When it was signed in 1972, scientists were not considered likely to develop biological weapons on their own, but at the best of their governments. However, the perception that scientists are just tools of their governments changed with the increased powers of biotechnology and the increased interest in bioterrorism by non-state actors. The ability to use biology for harm is no longer the province of teams of scientists and large budgets, but a possibility for a trained scientist working alone at the bench. As a reflection of this new era, BWC treaty members are currently discussing measures to influence scientists' behaviour, including professional codes of conduct and increased pathogen security.

8. CONCLUSIONS

Only through international coordination can transboundary animal diseases such as rinderpest be eliminated or eradicated. Concerted efforts by national authorities, with the assistance of reference laboratories for confirmatory diagnosis or vaccine development and quality control, the guidance of able international technical assistance, and investment of the international community for the establishment of regional approaches and networks of laboratories and epidemiological units, have placed the world on the threshold of worldwide eradication in the wild of a second animal pathogen.

After many years of persistence in Pakistan, the virus was eliminated from the Indus River buffalo tract in 2001 and there is now growing confidence that the whole of Asia is free from rinderpest. In Africa, the reservoir of infection in southern Sudan was also finally eliminated in 2001 leaving only one area where back-tracing is urgently required to resolve varying opinions as to the meaning of declining levels of rinderpest antibodies in the populations under surveillance.

FAO has worked with GREP, OIE and AU-IBAR as partners to develop control strategies and to implement programmes to reduce the clinical incidence of rinderpest and, in a later phase, the occurrence of rinderpest virus. Though difficult, this has brought the disease to an undetectable level in the last 14 years and in 2007 we have dared to believe that the virus has been eliminated. This has been a remarkable achievement for veterinary science and a proof of national commitments as well as a victory for the international community.