SPECIAL ISSUE
RINDERPEST

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EMPRES
EMERGENCY PREVENTION SYSTEM

FREEDOM FROM THE WORLD NO. 1 CATTLE PLAGUE: RINDERPEST

AND...

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FAO Animal Production and Health Division

The Global Rinderpest Eradication Programme as the spearhead for EMPRES

The significance of the Global Rinderpest Eradication Programme (GREP)[1] cannot be fully understood without recalling its spearheading role in the animal health work of the Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases (EMPRES) at the Food and Agriculture Organization of the United Nations (FAO).

GREP started in 1994 as a follow-up to the creation of EMPRES. As a single target disease programme, GREP soon became a model for the fight against transboundary animal diseases. EMPRES focuses on a "shift to the left" in the disease outbreak time line, which seeks to shorten the time between the commencement of an incident, and its detection and the response. EMPRES also follows the adage that prevention is better than cure. Shifting attention to early warning, early detection and early response opens the door to progressive disease control. Rinderpest was singled out as the logical first target because of its high impact and because a growing number of countries had shown that the disease could be eliminated. Knowing that important economic rewards had come within reach, the public veterinary services of countries in Africa and Asia were therefore ready to join forces and implement regional roadmaps for the progressive control and elimination of rinderpest.


PETER L. ROEDER
Omdurman cattle market

The GREP success story tells of positive results generated by a broad network of partners. FAO has always sought a facilitatory rather than a leadership role, promoting and securing concerted efforts and assisting the coordination and harmonization of inputs. The predominant role of regional animal health bodies has been vital to success, permitting the streamlining of public veterinary services across ecosystems. Rinderpest eradication brought countries together, and sometimes also overcame the boundaries and moved beyond animal health technical realms. Support to GREP at the international level came through an extensive fabric of finance and technical assistance agencies. GREP also brought ever-stronger collaboration between FAO and the World Organisation for Animal Health (OIE).

GREP activities spanned from local to global arenas. At the grassroots level, community animal health workers explored novel disease surveillance approaches. Pastoral and nomadic societies in remote rural settings were encouraged to take disease control activities into their own hands, supporting real-time disease intelligence at the field level and facilitating the tasks of epidemiologists and field veterinarians. The rinderpest virus comprised several distinct lineages, which broadly matched the

[1] All the aconryms used in this Special Edition are listed on pages 66 and 67.

prevailing mosaic of livestock husbandry landscapes and ruminant distribution patterns. The last evidence for rinderpest virus circulation dates to 2001 in the Somali ecosystem in Kenya, where a broad group of local stakeholders spent many years of sustained effort before concluding the fight against the disease in an ecosystem that spanned parts of three countries (Ethiopia, Kenya and Somalia).

As the various regional rinderpest eradication programmes made progress, with some countries obtaining international recognition of freedom and being followed by others, it became increasingly clear that investment in early detection and response held the key to progressive control of any transboundary or new emerging animal disease. This enhanced awareness of the need for every country or nation to have a proficient animal health system that is adequate for the multiple challenges confronted and ready to collaborate in and support regional-level surveillance and laboratory networks. Rinderpest eradication has arguably changed the way countries approach the management of transboundary animal diseases, and a growing number of countries are now exploring progressive control pathways for other high-impact diseases, such as foot-and-mouth disease, peste des petits ruminants or brucellosis.

Rinderpest eradication has arguably changed the way countries approach the management of transboundary animal disease

However, while the underlying principles applied to GREP and EMPRES remain sound, disease control thinking has to adapt to some new realities. A range of global factors are enhancing the spread of transboundary animal diseases, prompting countries to step up prevention and control just to preserve the status quo. Demographic forces, people's greater mobility, increases in the trade and traffic of live animals and their products, climate change, and the rapid growth of the livestock sector in countries with a growing middle-income class all contribute to a constant threat of globalized transboundary animal diseases. Food and insect vector-borne diseases increasingly find their way into new territories, sometimes at an intercontinental or inter-hemispherical scale.

Globally, human exposure to pathogens of animal origin has never been as high as it is today. This includes wildlife-based pathogens found in reservoirs such as non-human primates, bats, rodents and birds, and zoonotic pathogens circulating in livestock. Influenza A viruses provide a worrisome example of "species jumps", involving wild birds, poultry, pigs and humans. The H5N1 highly pathogenic avian influenza and the H1N1 pandemic influenza illustrate humankind's vulnerability to infectious disease agents of wildlife and livestock origin.

As well as the globalization of disease agents and higher human-animal contact rates, the current dynamics in world food and agriculture also contribute to the emergence of novel diseases, including through human encroachment on protected forest and game reserves. The world's agricultural areas continue to grow, at least in part because of the rapidly growing demand for feed cereals. Resource exploitation compromises the integrity of remaining natural landscapes, and the resulting upsurges of disease may be an indication of unsustainable natural resource management. As health risks at the human-animal-ecosystems interfaces increase, there is a growing need for cross-sectoral collaboration and an inter-disciplinary approach to the prevention and management of existing and emerging diseases.

In recognition of these dynamics, FAO has united the EMPRES units for animal health, plant protection and food safety into a single Food Chain Crisis Management Framework. This framework supports the creation of a corporate "One Health" work stream, broadening health protection measures beyond routine disease control and prevention, and introducing the notion of social and agro-ecological resilience as components in the management of disease threats. The rationale for broadening the health management approach also stems from the realization that conventional "fire-fighting" no longer suffices to halt disease flare-up. To understand how disease emergence and emergencies may be prevented, it is necessary to pay more attention to the agricultural, natural resource management and socio-economic drivers of disease emergence and the underlying causes of the intolerable persistence of chronic disease burdens in countries with poorly functioning health systems. This transformation of health management entails the ultimate shift to the left on the disease outbreak time line.

It is worth noting that the shift towards early warning, early detection and early response established under GREP has paved the way for making the adjustments in disease prevention that are now required. The benefits of GREP surpass by far the abolition of the world's number one cattle disease.

Contributor: Jan Slingenbergh (Head, EMPRES-Animal Health)

The role of FAO in the eradication of rinderpest

Introduction

In 1945, when the United Nations was established to succeed the League of Nations, the Food and Agriculture Organization of the United Nations (FAO) was one of the first specialized agencies to be set up. During its first Conference, held in Quebec (Canada) in the autumn of 1945, both the assets and mandate of the International Institute of Agriculture (IIA), created in May 1908, were handed over to FAO. In line with the IIA vision, FAO convened the first international meeting (1946) on animal health in London (United Kingdom). This aimed to explore how the Organization could best assist the harmonization of efforts to contain high-impact livestock diseases, particularly those that were transboundary in nature and were seriously affecting human nutrition, following the global war that had just ended. Rinderpest was at the top of the list, and continued to dominate the animal health agenda ever since. The first role of FAO was to help develop improved vaccines that were sufficiently low in cost for extensive rinderpest control operations. For the first time there was hope of eradicating the disease (Hambidge, 1955). As there was little international collaboration in rinderpest control and research during that period, FAO took a coordination role, which would lead – after almost 65 years – to the global eradication of rinderpest in June 2011.


FAO/GIULIO NAPOLITANO

Livestock in Ethiopia

The role in the production and use of vaccines

In April 1947, the Sub-committee on Animal Health of the FAO Standing Committee on Agriculture recommended that FAO should assist in the distribution and establishment of the then novel attenuated avianized rinderpest virus vaccines developed by a team of United States and Canadian scientists at the Grosse Isle Laboratory in Lower St. Lawrence River, Canada. Towards the end of 1947 two veterinarians were assigned to the FAO special advisory group in China, to assist the Chinese in the future development of avianized and lapinized rinderpest vaccines. At the end of April 1948 a veterinarian, K.V.L. Kesteven, was appointed to join FAO's staff in Washington, DC (the United States of America), and was assigned primarily to work on the problem of rinderpest (United Nations Interim Commission on Food and Agriculture, 1945; Hambidge, 1955).

In the following years, the eminent Japanese virologist Junji Nakamura advised the Governments of Egypt and Nigeria on the production of rinderpest vaccine, while S.A. Evans advised the Sudanese Government. An important international workshop organized by FAO was held at Izatnagar, India, early in 1953, under the direction of S. Datta, and was concerned with the manufacture of live virus vaccines, particularly the rinderpest vaccine. Two years later, R. Daubney ran a similar international training workshop in Cairo (Egypt). This was followed in 1959 by another workshop in Pakistan under the direction of G.G. Alton (FAO, 1955).

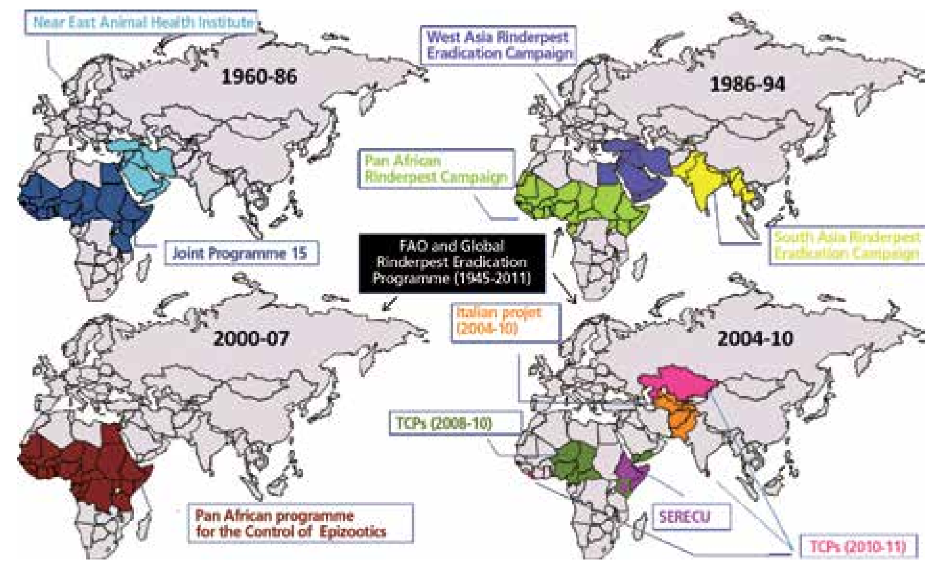
Thermovax was proved key to rinderpest control in remote pastoral areas

In the 1950s, FAO supported the use of lapinized and lapinized-avianized attenuated vaccines developed by Nakamura. Meanwhile, Walter Plowright and colleagues at the East Africa Veterinary Research Organization were developing an attenuated tissue culture vaccine, intended to replace the goat-adapted vaccines that had been used extensively in Asia and Africa throughout the 1940s and 1950s – and to good effect, despite their residual virulence and demanding production procedures. The new safe and effective vaccine was evaluated extensively in the early 1960s in Africa. As a result, from 1970 onwards, FAO was able to recommend that this tissue culture vaccine should be used in all affected and at-risk countries (FAO, 1993; WHO/FAO/OIE, 1968). One challenge to its use was the necessity of keeping the vaccine cold (in hot climates), to prevent the rapid loss of viral infectivity, rendering the vaccine useless. This cold chain problem was ameliorated to an extent by the use of freeze-drying, first applied to goat-adapted rinderpest vaccines in Kenya. Subsequently, in the 1980s, adaptation of the virus to VERO cells and an improved freeze-drying process to reduce residual moisture enabled Jeffrey Mariner, funded by the United States Agency for International Development (USAID), to produce a vaccine formulation with enhanced thermo-stability. This new formulation allowed the tissue culture vaccine to retain its potency for a month or more (as long as it was not reconstituted), even in the extremely hot conditions encountered in many of the countries where it was needed. Production of the vaccine, called Thermovax, was successfully transferred to a number of vaccine manufacturers and proved key to rinderpest control in remote pastoral areas, using community-based animal health workers.

The role in establishment of veterinary services

In the early days, FAO experts and consultants carried out assignments in most countries where rinderpest was endemic, with a focus on setting up veterinary services to control diseases. R. Daubney was one of the pioneers at the Kenya Veterinary Services, and later he was tasked with advising the Governments of Egypt and India on the control of rinderpest by national mass vaccination campaigns, which were spectacularly successful when they were implemented in the 1950s. Concurrently, in Cambodia, K. Fukusho, T. Furutani and H.L. Stoddart established a production plant for a lapinized-avianized rinderpest vaccine, and used the vaccine in the field to control the disease. J.R. Hudson was similarly occupied in Thailand. For nearly two decades, V.G. Hinds was a consultant in Bangladesh, India and Pakistan, designing, constructing and operating biological plants producing lyophilized rinderpest vaccine. In the late 1950s, H.B. Shaki established a veterinary service in Nepal to combat rinderpest (United Nations Interim Commission on Food and Agriculture, 1945). As rinderpest was suppressed, FAO assisted countries' veterinary services with the final stages of rinderpest elimination, halting vaccination and providing evidence of the absence of the virus through application of different surveillance tools. The Organization also contributed to the standard-setting activities of OIE. In addition, FAO supported the training of epidemiologists and laboratory staff and the procurement of laboratory equipment for almost all the countries infected by rinderpest.

Figure 1: Regional programmes/projects



The role in creating regional institutions

In 1948, FAO and the British Colonial Office organized a pan-African meeting in Nairobi (Kenya) specifically to discuss methods of controlling rinderpest. Participants from 32 countries unanimously concluded that the eradication of rinderpest was a practical possibility and should be carried out without delay. The African Rinderpest Conference, examining the question of eradication in Africa, drew attention to the special problems that existed in certain territories and envisaged that assistance might be required in the spheres of finance, provision of personnel and provision of vaccines. The conference also warned that overstocking could become accentuated as control of rinderpest progressed, and stressed that attention to the marketing and utilization of surplus stock was imperative. The conference considered that FAO would be the most suitable global organization to undertake solution of the problems (FAO, 1955). Accordingly, it asked for FAO's assistance with the creation of an African Rinderpest Bureau (a precursor of the present-day African Union's Inter-African Bureau for Animal Resources [AU-IBAR]), which was to play a key role in supporting rinderpest eradication from Africa. It was proposed that its creation should be initiated and established in 1950, by the Commission for Technical Cooperation in Africa South of the Sahara (CCTA) and the Foundation for Mutual Assistance in Africa South of the Sahara (FAMA). A working party of these two bodies studied the proposal for the creation of the bureau and widened its functions to include all African epizootic diseases of livestock. Thus, in 1952, the bureau was established at Muguga, Kenya, as the Inter-African Bureau of Epizootic Diseases (IBED) with W.G. Beaton as its first director. Accepting morbid conditions in addition to epizootic ones, IBED became the Inter-African Bureau of Animal Health (IBAH), which in 1970


FAO/F. PALADINI
Deaths


RICHARD KOCK
Diarrhoea


RISTO HEINONEN
Discharge

broadened its responsibilities to include animal production and was renamed IBAR (FAO, 1993).

The first Joint FAO/OIE Far East Meeting on Animal Health was held in Karachi (Pakistan) in 1952, the second in Bangkok (Thailand) in 1954, and the third in Tokyo (Japan) in 1956. Since January 1959, responsibility for work in the field of animal health was taken up by the Animal Production and Health Division of FAO. Later, in 1976, as outcomes of these meetings, the FAO Animal Production and Health Commission for Asia, the Far East and the Southwest Pacific (APHCA) was established. When the first session of APHCA opened, in Bangkok (Thailand) from 7 to 11 June 1976, Bangladesh, India, Malaysia, Nepal, the Philippines, Sri Lanka and Thailand were members. In setting its operational guidelines, the commission categorically decided that its operational thrusts would be aimed at action-oriented programmes in livestock and poultry development, which would include such activities as disease control. Animal production and health would be covered on both a national and a regional basis (APHCA, 1976).

In the late 1950s, FAO accelerated the foundation of the Near East Animal Health Institute at several sites, overseen by Yoshihiro Ozawa. The rinderpest unit was established in Cairo (Egypt) and was equipped to diagnose rinderpest and produce rinderpest tissue culture vaccines (United Nations Interim Commission on Food and Agriculture, 1945).

Improving the quality of rinderpest vaccines for use in African vaccination programmes was a challenge, which FAO met by establishing the Pan African Veterinary Vaccine Centre (PANVAC) based in Senegal and Ethiopia for the quality assurance of vaccines, under the management of Daouda Sylla and Mark Rweyemamu. Established as a service for AU-IBAR for the Pan African Rinderpest Campaign (PARC), PANVAC benefited from funding provided by the FAO Technical Cooperation Programme (TCP) supplemented later with inputs from the United Nations Development Programme (UNDP), the European Commission and Japan. It made an invaluable contribution to rinderpest control and is now institutionalized within the AU.

Role in coordination

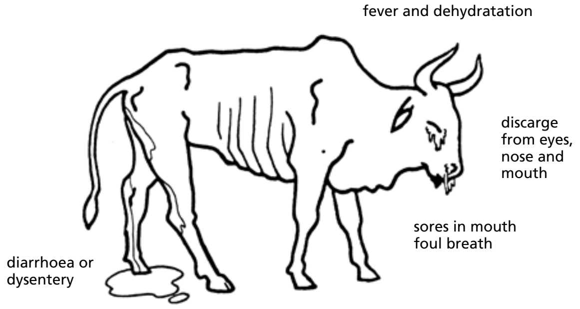
Energized by the second great African rinderpest pandemic, which hit sub-Saharan Africa in the early 1980s, FAO and partners lobbied strongly for a concerted effort to eradicate rinderpest from the continent; the Pan-African Rinderpest Eradication Campaign was the result. For more than 50 years, FAO was crucial in establishing and coordinating other regional rinderpest control campaigns (Figure 1): the African Joint Programme 15 (JP15); the Near East Animal Health Institute's regional project; the Middle and Near East Regional Animal Production and Health Project (MINEADEP); PARC; and the West Asia Rinderpest Eradication Campaign (WAREC). A South Asia Rinderpest Eradication Campaign (SAREC) was energetically promoted, but did not materialize and was replaced by individual country livestock development programmes funded by the European Commission (APHCA, 1976) with coordination by the GREP Secretariat. After it came to an end, PARC was followed by the Pan African Programme for the Control of Epizootics (PACE). This generated the Somali Ecosystem Rinderpest Coordination Unit (SERECU), which played a key role in coordinating activities and continued until the three countries (Ethiopia, Kenya and Somalia) could be accredited as rinderpest-free. During PARC and PACE, FAO maintained a unit within AU-IBAR in Nairobi (Kenya) focused on studying the epidemiology of rinderpest across the African continent. This oversaw the success of the various emergency campaigns against rinderpest in West Africa in the period immediately after the discovery of the second African epizootic (1980s), and was active in strategy setting.

In 1994, the FAO Council approved the establishment of EMPRES. Salient under EMPRES is GREP, which was designed as a time-bound programme aimed at ensuring the evidence-based global eradication of rinderpest virus by 2010. In addition, the GREP Secretariat contributed to the standard-setting activities of OIE by being involved in production of the Terrestrial Animal Health Code – Rinderpest Chapter, the Manual – Rinderpest Chapter and surveillance guidelines and in the rinderpest ad hoc group, overseeing the accreditation of countries as rinderpest-free. Through this programme, GREP assumed the responsibility for assisting the veterinary services of rinderpest-affected countries to eliminate the infection, develop or assess their evidence relating to the demise of the infection (clinical searches, sero-surveillance, contingency planning), and express this in accordance with the rules for accreditation through dossier presentation, developed by OIE. In just 17 years, it has provided technical assistance and guidance to many countries and regions in their rinderpest control, as well as providing technical guidance to international organizations and donors

Consultative meetings

From the late 1940s onwards, FAO (Headquarters and in the field) convened a series of consultative meetings. The objectives were to find ways of producing suitable vaccines for controlling the disease, formulating strategies for control, guiding countries, and monitoring progress in disease control/eradication. Latterly, it was

Figure 2: Rinderpest's main clinical signs



Source: PARC/FAO/OAU-IBAR

GCP/RAF/218/JPN

recognized that regional coordination of campaigns against rinderpest would be the only realistic approach to controlling the disease, as isolated national actions would lead only to sporadic and unsustainable improvements. FAO sent an observer to the first international meeting convened for the inauguration of JP15 in 1961 (in Kano, Nigeria). When the campaign was extended to eastern Africa, using funds from UNDP, FAO ran training schemes in Ethiopia and Somalia. A few years later, a similar rinderpest conference was convened by FAO for Asia and the Far East, in Bangkok (Thailand), at which several governments agreed to take all possible steps to control the widespread outbreaks of rinderpest by coordinating their programmes with those of neighbouring countries, with the objective of ultimate eradication. In 1968, the World Health Organization (WHO), FAO and OIE jointly organized a meeting in Paris to draw up standards for the production of avianized, caprinized and lapinized rinderpest vaccines. A further meeting in 1971 drew up the standards for rinderpest cell culture virus vaccine (APHCA, 1976; FAO, 1955, 1993; United Nations Interim Commission on Food and Agriculture, 1945). Several expert meetings or training courses/workshops reviewed the technical progress on FAO-GREP and advised accordingly. The technical consultations held during GREP emphasized the need for epidemiologically determined strategies and encouraged adoption of the concepts of performance indicators, bench-marking and risk management, and discouraged prolonged mass vaccination programmes. The GREP strategy that led to global eradication was guided by two underlying thrusts: i) time-bound milestones as set out in the GREP Blueprint; and ii) basic risk analysis principles.

Networking in epidemiology and laboratory diagnostics

The world has been placed at the point of worldwide rinderpest eradication by the concerted efforts of national authorities, with investment in regional programmes from the international community. Research institutes and reference laboratories operating within regional laboratory networks provided the vaccines, diagnostic, surveillance and epidemiological tools to make this possible. Very active in this field was the World Reference Laboratory (WRL) established by FAO at the United Kingdom's Institute for Animal Health (IAH) Pirbright Laboratory, which conducted seminal work on diagnostics and molecular epidemiology, and the Joint FAO/International Atomic Energy Agency (IAEA) Division based in Vienna (Austria). Networks established in Africa and Asia provided fora for regional experts to extend their understanding within an environment that supported the validation of assays and technology transfer to key countries, through FAO- and IAEA-funded projects.

The world has been placed at the point of worldwide rinderpest eradication by the concerted efforts of national authorities

Partnership and donor support

Rinderpest eradication would not have been achieved during the last 30 years were it not for the strong partnerships developed among FAO, national authorities, OIE, regional organizations such as the AU, and numerous donor agencies. Substantial and enduring financial support underwrote the resources and resolve needed to achieve eradication. For the most part, donor assistance to FAO came from the European Development Fund

(EDF), UNDP and organizations such as USAID, the United Kingdom's Department for International Development (DFID), the Government of the Republic of Ireland and the Italian Development Cooperation (Cooperazione Italiana). FAO's TCP project funding was used to control rinderpest outbreaks rapidly and to undertake activities to strengthen laboratory diagnostics, emergency preparedness planning, surveillance and capacity building. This FAO function was highly appreciated by recipient countries.

Declaration of the Joint FAO/OIE Committee on Global Rinderpest Eradication

The agreement between FAO and OIE establishing the Joint FAO/OIE Committee on Global Rinderpest Eradication (the Joint Committee) was concluded in June 2009. The main function of the Joint Committee was to provide a report of its findings to the Directors-General of FAO and OIE, stating whether it was confident that the world could be declared free from rinderpest, and/or recommending the actions to be taken for this achievement to be attained. More concretely, the Joint Committee was to: i) advise the Directors-General of FAO and OIE on potential gaps and risks regarding the proof of freedom from rinderpest, to allow a firm statement declaring the end of rinderpest virus circulation in the world; ii) draft a joint FAO-OIE text for the global declaration of freedom from rinderpest in mid-2011; and iii) draft an international agreement outlining the principles and responsibilities for oversight, and regulatory actions to ensure freedom from rinderpest in the post-eradication era. The Joint Committee also produced draught guidelines for the global sequestration of rinderpest virus and virus-containing material in biosecure laboratories. Its final report indicated that it concurred with the conclusions of OIE's Scientific Commission that rinderpest had been eradicated.

Conclusion

With FAO-GREP's field objectives realized, focus needs now to be directed to maintaining worldwide freedom from rinderpest in the post-eradication era, through the destruction or safe custodianship of remaining stocks of vaccines for emergency use or of virus samples that may be held at research or diagnostic facilities. Actions are also needed to develop a post-eradication strategy, which will include safeguarding against rinderpest resurgence through emergency planning, to assure public confidence in the reality of eradication and to ensure that the benefits of the achievement are reflected in cost savings from the cessation of vaccination and in improved trade prospects. Above all, the remarkable achievement should be reflected in a renewed impetus to manage effectively the remaining transboundary animal diseases. Rinderpest eradication has arguably changed the way countries approach transboundary animal disease burdens, with a growing number of countries today exploring progressive control pathways for other high-impact diseases, such as foot-and-mouth disease, peste des petits ruminants and brucellosis. Lessons learned from rinderpest eradication, although not universally applicable, can usefully inform policy and strategy setting for other diseases.

Contributors: F. Njeumi (FAO) and P.L. Roeder

Joint FAO/OIE Committee on Global Rinderpest Eradication final report

Introduction

The Joint FAO/OIE Committee was made up of Jean-Francoise Chary from France, Steve Edwards from the United Kingdom, Yoshihiro Ozawa from Japan, James Pearson from the United States of America, Arnon Shimshony from Israel, Daouda Sylla from Mali and William Taylor from the United Kingdom, who chaired the Committee.

The Joint Committee was asked to receive and review all reports from OIE indicating the freedom from rinderpest of all countries and territories worldwide, supplemented by information provided by FAO indicating the technical soundness of the surveillance and diagnostic methodologies underpinning these reports. This the Committee did.

The Joint Committee was also asked to advise the Directors-General of FAO and OIE as to whether the evidence it had reviewed entitled them to announce that rinderpest had ceased to exist outside a laboratory environment. Such advice was given.

The Joint Committee was asked to receive technical assistance from the OIE Biological Standards Commission on drafting a set of guidelines for the secure sequestration of residual rinderpest virus stocks within a laboratory environment. This it did.

FAO/GIULIO NAPOLITANO

The Joint FAO/OIE Committee, Rome

The Joint Committee was asked to advise FAO and OIE on a contingent emergency vaccination policy to be applied after eradication. This issue was examined but was deferred until the conclusions of an ongoing risk analysis become available, after which the Joint Committee will be able to advise on future surveillance needs and the strategic creation of vaccine banks.

The Joint Committee was asked to contribute guidance to the preparation of a published history of rinderpest and its global eradication. The Committee found that many aspects of the history of rinderpest were already published but not the history of its eradication, which it endorsed as a viable project.

The Committee was extant from December 2009 until June 2011 and held four regular meetings.

Its findings and recommendations are summarized in the following.

Findings of the Joint FAO/OIE Committee

Information on disease situation in countries and on relevant activities

The Joint Committee was given access to the OIE archive of sanitary reports and disease status dossiers on rinderpest submitted by OIE members. The Joint Committee observed that the number of infected countries worldwide had steadily decreased.

The Joint Committee was also given access to FAO archives and was fully informed of GREP activities in regions and countries.

Development of the OIE Pathway and evaluation of disease status applications

The Joint Committee recalled that the guidelines for surveillance were originally developed and published in 1989 by OIE, as a guide to assist its members in demonstrating freedom from rinderpest post-vaccination, to assure trading partners and monitor the progress of eradication programmes. Ceasing vaccination was a prerequisite for proceeding to the next steps of the Pathway leading to disease freedom.

In 1999, OIE members endorsed the decision to establish a baseline list of historically rinderpest-free OIE members. In 2000, a first list of officially recognized rinderpest-free members was adopted by the body now referred to as the World Assembly of OIE Delegates. Members not historically free were then invited to submit detailed evidence to support claims of rinderpest freedom.

FAO/GIULIO NAPOLITANO

The Joint FAO/OIE Committee, Rome

The Joint Committee accepted the concept of historical freedom in accordance with relevant OIE standards (baseline list of year 2000, which counted 86 countries as free of rinderpest infection). The Joint Committee further noted the recommendations of the OIE Scientific Commission for Animal Diseases (the Scientific Commission), which took into account the progress of global rinderpest eradication and knowledge of the distribution of historical rinderpest risks among different regions of the world, regardless of their membership of OIE. A list of countries located in world regions that had never faced rinderpest outbreaks or had managed to eradicate rinderpest several decades earlier (the Americas, the western part of Europe, and Oceania except Australia) was elaborated by the OIE ad hoc expert group on rinderpest. This expanded list was endorsed by the Scientific Commission in 2008.

The Joint Committee noted that the OIE Scientific Commission had the mandate to review applications for official recognition of rinderpest-free status on its own until 2004.

From 2004 onwards, the Scientific Commission requested the support of an ad hoc group composed of rinderpest experts, including those from EMPRES, to evaluate the submitted dossiers, particularly those of OIE members not historically free, and provide recommendations to the Scientific Commission for consideration. The Scientific Commission, in turn, annually forwarded its proposals on recognition of the rinderpest-free status of countries and territories, in the form of a resolution to the World Assembly of OIE Delegates, for adoption.

In January 2011, the OIE ad hoc group evaluated the last remaining countries, and the process of reviewing the rinderpest freedom of all 198 countries and territories with susceptible animal populations worldwide was completed. The Joint Committee commended this endeavour.

The Joint Committee supported the evidence and conclusions detailed in the ad hoc group reports and acknowledged the expertise of the members of the group and of the Scientific Commission.

International standards for diagnosis and vaccines

FAO had provided substantial technical assistance through major campaigns in Asia and in Africa contributing to bringing the disease largely under control

The Joint Committee noted that in 1991 the OIE Biological Standards Commission initiated a programme for the development of international quality standards for laboratory diagnosis of rinderpest and manufacture of rinderpest vaccines. This activity resulted in the harmonization of test protocols and the designation of reference reagents to be used in the tests, facilitating surveillance and greatly contributing to the successful outcome of the campaign for rinderpest eradication. These standards are published in the OIE Manual of Diagnostic Tests and Vaccines for Terrestrial Animals.

FAO efforts towards the eradication of rinderpest

The Joint Committee found that since its foundation, FAO had provided substantial technical assistance (including via the Joint FAO/International Atomic Energy Agency [IAEA] Division) through major campaigns in Asia during the 1950s and 1960s and in Africa from 1960 to 1976, contributing to bringing the disease largely under control. However, because of weaknesses in operational and structural follow-up, rinderpest had resurged and spread widely in sub-Saharan Africa and Asia. At its 83rd Session in June 1983, the FAO Council endorsed the recommendation of the Committee on Agriculture regarding the need to formulate national and international strategies for animal health, including action to control rinderpest. Particular concern was expressed regarding the resurgence of this disease in Africa, the Near East and Asia. The Council also requested FAO to provide assistance to African countries in controlling the disease and to mobilize support for the newly proposed Pan African Rinderpest Campaign (PARC) through the International Office of Epizootics (OIE, now the World Organisation for Animal Health), the Organization of African Unity (OAU, now the African Union [AU]) and the European Economic Community (now the EU). In 1987, FAO held an expert consultation on the global strategy for the control and eradication of rinderpest. The experts concluded that global eradication was justified and feasible by expanding the campaign from Africa to the Middle East and South Asia.

FAO EMPRES expert and technical consultation meetings assisted in coordinating several regional campaigns in Asia, the Middle East and Africa, and ensured that national campaigns were fully abreast of technical issues and that there were opportunities for information exchange regarding disease occurrence, incidence or prevalence at the country and regional levels. These efforts aimed to guide countries in vaccine production and quality control, emergency vaccination campaigns and the OIE Pathway, and then to provide assistance in surveillance activities and assembly of the evidence needed for preparing country dossiers, which were evaluated by OIE.

The Joint Committee also recognized the contribution of diagnostic and training networks, the establishment of diagnostic laboratories and the formulation of guidelines. In the early 1980s, enzyme linked immunosorbent assay (ELISA) technology was developed from a research tool into an affordable diagnostic laboratory technology. Performance indicators and standard operating procedures for rinderpest sero-monitoring, sero-surveillance and related quality assurance aspects were completed.

From 1994, FAO/EMPRES strengthened its responsibility for technical leadership and global coordination through GREP, with 2010 as the projected deadline for rinderpest eradication. Following technical consultation in late 1998, an intensified GREP was launched, marking the transition to the final eradication thrust, based on epidemiological understanding of suspected reservoirs of infection in marginalized extensive high-risk pastoral systems. The focus was on containment, elimination and proving freedom of disease. The Committee also acknowledged the laboratory networks established, and their role in sero-monitoring and surveillance.

The Joint Committee noted that GREP had been successful and had achieved, in cooperation with OIE and partners, its stated objective of eradicating rinderpest virus by the 2010 deadline (the last outbreak was in 2001 and the last use of vaccine in 2006).

Cooperation among governments, international and regional organizations and other partners

The Joint Committee observed that the commitment of national veterinary services was pivotal. The contributions of reference laboratories, advanced diagnostics and molecular epidemiology were also significant. The Committee also acknowledged the important roles played by networks of specialist groups supported by OIE and FAO, and by specialized regional organizations such as AU's Inter-African Bureau for Animal Resources (AU-IBAR) and the South Asian Association for Regional Cooperation, among others. These concerted efforts made it possible to obtain the evidence that there were no more residual foci in domestic or wildlife species. Other actors such as regional organizations and funding partners made significant contributions to the process of eradication.

Virus sequestration

The Joint Committee noted that virulent and attenuated rinderpest virus samples and vaccine stocks continued to be held in laboratories in a number of countries worldwide. The Joint Committee noted that FAO and OIE were in the process of establishing an inventory of institutes holding rinderpest virus-containing material through questionnaire surveys. Preliminary results of these surveys indicated that virus-containing material was stored in variable biosecurity conditions in more than 20 countries. The Joint Committee was informed of World Health Organization (WHO) experience on smallpox eradication and noted that many approaches taken by WHO were also applicable to rinderpest for the design of post-eradication activities.

Virulent and attenuated rinderpest virus samples and vaccine stocks continued to be held in laboratories in a number of countries worldwide

Significance of global rinderpest eradication

The Joint Committee noted that preliminary socio-economic analysis on the eradication programme strongly indicates that rinderpest eradication could be considered as a global public good. The Joint Committee also noted that the experience gained during the rinderpest eradication process should be kept and be used for future eradication of other animal diseases.

Conclusions

In the light of these findings, the Joint Committee concluded the following:

i. Rinderpest as a freely circulating viral disease has been eliminated from the world; and
ii. The presence of virulent or attenuated rinderpest virus in laboratories constitutes a potential threat to global biosecurity.

Recommendations

1) A resolution should be taken forward by FAO and OIE, for adoption by their governing bodies, declaring global rinderpest eradication and implementing subsequent necessary measures.
2) Guidelines on rinderpest virus sequestration as agreed by the Joint Committee in consultation with the OIE Biological Standards Commission should be implemented by national veterinary authorities, OIE and FAO.
3) FAO and OIE should, as a matter of urgency, continue to work in close collaboration on the following:
   a. develop a strategic plan to guide the post-eradication activities at international level;
   b. complete an analysis of the risks of re-emergence of rinderpest virus, and its consequences;
   c. prepare an international contingency plan based on the risk analysis;
   d. set up a joint FAO/OIE Advisory Body on rinderpest, defining its terms of reference and membership; this Advisory Body may set up subcommittees, for example to monitor rinderpest research activities.
4) National veterinary authorities should update national contingency plans in line with the guidelines for rinderpest virus sequestration and the international contingency plan.
5) FAO and OIE should establish an appropriately funded mechanism for oversight and approval of facilities holding rinderpest virus containing material, in conjunction with national regulatory authorities and, where appropriate, with other international organizations.
6) FAO and OIE should maintain archives of existing documents (including disease status dossiers); digitization of files should be considered where possible, as well as identification of documentation that should be made publicly accessible.
7) FAO and OIE should find and collate suitable education and training materials, particularly films of rinderpest disease, and package them in a way that

is accessible to as wide an audience as possible, through official websites and other publicly accessible file depositories on Internet to maintain a high level of awareness of the disease.

8) National authorities should ensure that:
   a. rinderpest remains a notifiable disease;
   b. a surveillance system (including rumour tracking and early detection) be maintained to detect disease events that could indicate rinderpest-like signs;
   c. suspect cases, including undiagnosed die-offs, be rapidly investigated (using existing mechanisms or, where appropriate, the FAO/OIE Crisis Management Centre-Animal Health) and necessary actions be promptly taken.
9) Ongoing support for FAO/OIE rinderpest reference laboratories should include adequate funding for maintenance of diagnostic capability.
10) FAO/OIE rinderpest reference laboratories should ensure inter-collaboration.
11) The use of rinderpest vaccines should be forbidden except for emergency use in the case of a rinderpest outbreak.
12) FAO and OIE should provide guidelines on control procedures, including the use of emergency vaccination.
13) Research on historical strains of rinderpest should continue, given that full sequencing promotes greater understanding of Morbillivirus evolution and full sequence data reduce the need to retain live virus stocks.
14) Re-creation of rinderpest virus from full genome sequences should be forbidden except in an authorized biosecure facility on approval by FAO and OIE.
15) An international Morbillivirus discovery and monitoring programme should be promoted and knowledge gained in rinderpest eradication should be transferred to potential control programmes for other Morbillivirus infections.
16) The need for possible novel (e.g. differentiating infected from vaccinated animals) vaccines and diagnostic tests should be determined by the Advisory Body in the light of the risk analysis.
17) Vaccines (including related equipment) should be manufactured in accordance with the OIE Terrestrial Manual and held in sustainably funded vaccine repositories (vaccine banks), coordinated by FAO and/or other appropriate bodies and in liaison with manufacturers; minimum number of repositories should be determined by the Advisory Body in the light of the risk analysis.
18) FAO and OIE should vigorously pursue the publication of experiences on rinderpest control and eradication in a book.
19) International standards and guidelines on rinderpest, including the OIE Terrestrial Animal Health Code, OIE Manual of Diagnostic Tests and Vaccines for Terrestrial Animals, and FAO Manuals, should be updated in the light of global eradication.
20) A specialist rinderpest secretariat should be maintained by FAO and OIE with adequate resources to deliver the rest of these recommendations, including the support to activities of the FAO/OIE Advisory Body.

OIE's contributions to the eradication of rinderpest

Following the unexpected reoccurrence of rinderpest in Belgium in 1920, due to infected zebu cattle in transit at Antwerp on the way from India to Brazil, chief veterinary officers from various regions of the world gathered in Paris in March 1921 and agreed to support a concerted international effort in the fight against rinderpest. This conference led to the creation of OIE[2] in 1924. The main objectives of OIE have remained unchanged since: to ensure transparency in the global animal disease situation; to collect, analyse and disseminate veterinary scientific information; to elaborate scientifically sound international standards and recommendations on disease control and on the quality of animal vaccines; and to encourage international solidarity in the control of animal diseases.

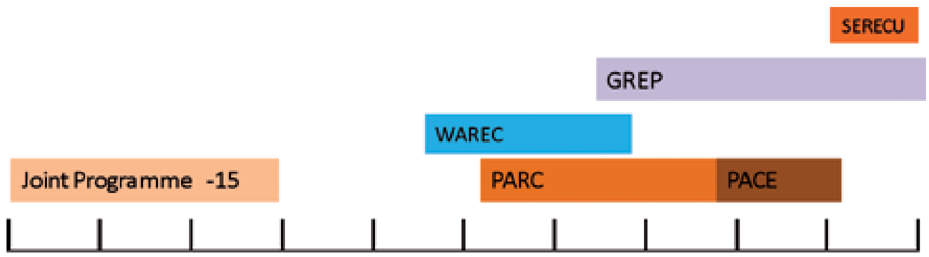
Immediately following the Second World War, in 1947 OIE was actively promoting international solidarity for rinderpest control by mediating among donors, vaccine producers and countries in need, thereby facilitating large-scale campaigns based on the most recent scientific information available. OIE started to commission national research institutes around the world to conduct work tailored to the needs of the international community of veterinary services, e.g., research on appropriate methods, including suitable virus inactivation procedures, to prevent the spread of rinderpest from occurring through international trade in bovine meat as well as on the standardization of safety of rinderpest vaccines.

Commencing in the 1960s, OIE, FAO and regional organizations launched and coordinated large-scale campaigns to strengthen capacities of member countries' in endemic areas to eradicate rinderpest and control other major transboundary diseases (Figure 1). Through these intensive control programmes, the eradication of rinderpest was achieved in almost all areas of the world between the 1960s and mid-1970s. However, the disappearance of clinical disease led to a discontinuation of vaccination campaigns in Africa and subsequently the re-emergence of the virus from a small number of endemic foci that had persisted in Africa leading to a devastating epizootic across the African continent. The disease had been controlled in South Asia owing to the vaccination programmes, but new approaches were necessary to eliminate foci that persisted in India and Pakistan during the 1980s and 1990s. The last outbreak in South Asia was reported in 2000 in Pakistan. The continuous development of better-adapted diagnostic tools, vaccines and surveillance methods was necessary to support a second round of campaigns to survey and permanently eradicate the disease region by region.

To respond to the request from the OIE members to provide more guidance on surveillance for rinderpest and on substantiation of claims for freedom from rinder-

[2] www.oie.int/en.

Figure 1: Large-scale campaigns in endemic areas



JP15 Joint Programme 15 (1960–1976), parts of sub-Saharan Africa
WAREC West Asia Rinderpest Eradication Campaign (1989-1994), larger Middle East region
PARC Pan African Rinderpest Campaign (1987–1998), parts of sub-Saharan Africa
GREP Global Rinderpest Eradication Programme (1994 – ongoing), worldwide activities
PACE Pan African Programme for the Control of Epizootics (1999–2007), parts of sub-Saharan Africa
SERECU Somali Ecosystem Rinderpest Eradication Coordination Unit (2006–2010), Ethiopia, Kenya and Somalia

pest *vis-a-vis* their trading partners, an OIE Expert Consultation on Rinderpest Surveillance Systems was held in Paris in August 1989, leading to the development of what would later be known as the "OIE Rinderpest Pathway". The "Recommended Standards for Epidemiological Surveillance for Rinderpest" were adopted by the OIE members in 1998 and paved the way for the OIE certification process of the rinderpest-free status of countries and zones.

After foot-and-mouth disease, rinderpest became the second disease to be included in the procedures of official recognition of countries' disease status. In 2000, the International Committee of OIE adopted the first resolution setting a baseline list of member countries that were free from rinderpest infection. The OIE members included in this very first list had previously documented that they met the requirements for rinderpest freedom based on historical grounds. From 2002 to 2009 the official list included also countries fulfilling the criteria of being free from clinical rinderpest disease and for rinderpest disease-free zones.

More than 260 dossiers of countries were evaluated by the OIE Scientific Commission for Animal Diseases for their rinderpest status between 1999 and 2011. Currently, 198 countries and territories have been considered as rinderpest infection-free by OIE. This represents all countries around the globe having rinderpest susceptible livestock.

The global eradication of rinderpest represents a major achievement for humankind, and in particular for the veterinary profession. Eradication of rinderpest would not have been possible without international solidarity across continents as well as firm commitment of international and regional organizations, without encouraging countries' transparency in reporting the disease situation, without OIE's efforts in disseminating new scientific information, and without the continued support from donors such as the EU. This said, the main contribution to global eradication of rinderpest came from the countries themselves and an uncountable number of highly dedicated individuals, be they farmers, veterinarians, scientists or local community workers.

Today, the fight against rinderpest continues: Clinical samples containing rinderpest virus and virus isolates are still kept in a number of laboratories in the world. These materials need be either safely destroyed or transferred to biosecure, approved laboratories. In case the virus is reintroduced to the environment accidentally or intentionally, the international community and individual countries need to put in place effective surveillance and notification mechanisms, including rumour tracking and rapid investigation to rapidly detect such an incident. Contingency plans should be in place at the international and national levels, ensuring that vaccines are made available in a timely manner, in case of emergency. While the disappearance of the disease has relieved countries and farmers from the heavy economic losses due to outbreaks for ever, investments must continue to sustain post-eradication activities. OIE is committed to continuing to work closely with its partners, in particular FAO, to keep the world free from rinderpest.

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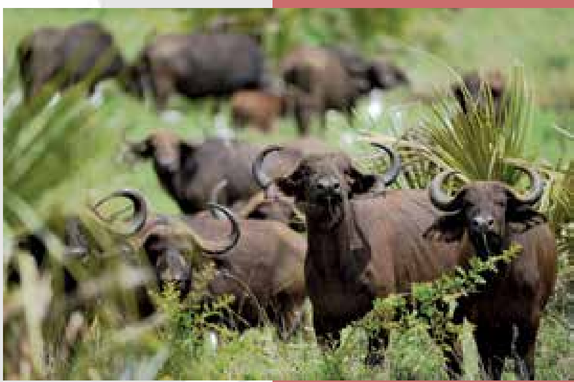
Rinderpest eradication in Africa

After its introduction into Africa in the 1880s, rinderpest became the most feared and most devastating disease to afflict the continent's cattle and wildlife herds. Outbreaks of the classical disease in cattle caused mortality rates of 10 to 90 percent. So devastating was this "cattle plague" that many countries worldwide made concerted efforts to stamp it out and, having once eliminated it, prevent its re-emergence. The disease was a serious threat to the livelihoods of millions of people in Africa. The presence or suspected presence in a country served as a major barrier to livestock trade, and many countries of the world, particularly in Africa, were denied access to valuable external livestock markets. This devastating blow to trade impoverished the pastoral peoples of Africa and dealt considerable blows to the economies of their countries.

The present-day African Union[3] Inter-African Bureau for Animal Resources (AU-IBAR)[4] was established in 1951 with responsibility for eliminating rinderpest from Egypt and sub-Saharan Africa, where continual east-west cattle movements prevented effective control by individual countries. Since then, with the European Union (EU) as the main donor, AU-IBAR has coordinated the eradication of rinderpest from Africa through five main projects: Joint Project 15 (JP15), 1962 to 1976; the Pan African Rinderpest Campaign (PARC), 1986 to 1998; the Pan African Programme for the Control of Epizootics (PACE), 1999 to 2007; the African Wildlife Veterinary Project (AWVP), 2002 to 2003; and the Somali Ecosystem Rinderpest Eradication Coordination Unit (SERECU) project, 2006 to 2010. In tandem with rinderpest eradication, the need to strengthen veterinary services was addressed.



FAO/TONY KARUMBA

Buffalo herd in Meru National Park, Kenya

From JP15 to SERECU, the main objective was the eradication of rinderpest from Africa. Alongside this main objective were other complementary and synergistic objectives. Under PARC, these were controlling contagious bovine pleuropneumonia (CBPP) through mass vaccination programmes; strengthening the capacity of national veterinary services to undertake vaccination campaigns; and supporting livestock policy reforms in participating countries, to ensure a better financial foundation for and greater sustainability of veterinary services. PACE had the complementary objective of strengthening national and regional capability to assess the technical and economic impacts of animal diseases and to generate appropriate programmes for controlling diseases. All five projects conducted enabling research.

The need for a concerted effort for rinderpest control and eradication was recognized during the 1950s, and in 1961 the heads of veterinary services in Africa launched the multi-national JP15, coordinated by the Organization of African Unity (OAU), to-

[3] www.au.int/.

[4] www.au-ibar.org/.

day's AU. JP15 aimed to vaccinate all cattle of all ages every year for three successive years, using live attenuated vaccines to confer durable immunity. The project was implemented in six phases from 1962 to 1976, in 22 countries in West, Central and East Africa, with co-funding from national governments, the European Development Fund (EDF), the United States Agency for International Development (USAID) and the Governments of Canada, Germany and the United Kingdom. The EDF funding was largely bilateral and did not directly involve AU-IBAR. Implementation was undertaken by national veterinary services and coordinated by AU-IBAR, which was essential for the smooth running of the campaign. AU-IBAR was also instrumental in transferring information to OIE and in keeping FAO abreast of progress.

Unfortunately, the phased implementation of JP15 left long gaps between actions; for instance, vaccinations in the Niger were completed two years apart. This led to the survival of residual foci of undetected rinderpest, which were instrumental in the resurgence of rinderpest epidemics in western Africa in the 1980s. JP15 did not develop an exit strategy beyond having national veterinary services eliminate the last vestiges of infection, which most of them did. Failure to resolve or even officially to recognize – the three or four persistent reservoirs of rinderpest infection in western and eastern Africa led to the undoing of most benefits. OIE was the only body in a position to understand that the virus had not been totally eliminated, on the basis of voluntary reports that it received from member countries, but the reporting process was inefficient at the time. The inadequacy of surveillance systems, the limited epidemiological knowledge concerning virus persistence and an excessive reliance on institutionalized mass vaccination therefore led to the resurgence of rinderpest at the end of JP15.


TRACY MCCRACKEN

Eland in Kenya

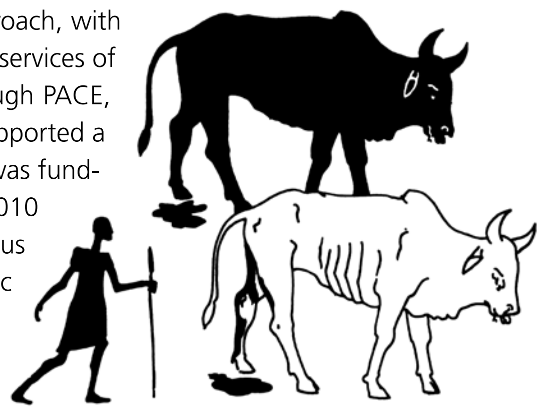
PARC was a more comprehensive programme that built on the achievements of and lessons learned from JP15. The project was a two-pronged effort combining regional activities through a coordination unit and national projects in 35 participating countries, between 1986 and 1998. The EU provided the bulk of the funding (EUR 115 million from EDF 6 and 7), with supplementary funding coming from bilateral donors: the United Kingdom, Italy, France, Nigeria and Japan. PARC was also implemented in phases, and funds allocated to each country were made available when an implementing protocol between the country and the local EU delegation was signed. Unlike JP15, PARC focused on strengthening veterinary services and implementing mass vaccination, with a parallel programme aimed at improving the delivery of veterinary services by creating revolving funds, promoting the privatization of veterinary services, and forming herders' associations. These latter components were regarded as part of a broader structural adjustment programme. In addition to vaccination against rinderpest, activities included communication campaigns, programme monitoring and technical assistance. Towards the end of PARC, it became apparent that mass vaccination was masking signs of clinical outbreaks and interfering with the use of sero-surveillance as a tool for detecting the presence, or confirming the absence, of rinderpest. This led to the progressive replacement of mass vaccination with increased surveillance and targeted vaccination.

The evaluation of PARC in 1996 recommended a continuation to consolidate the gains made and facilitate the eradication of rinderpest from the remaining foci. PARC was succeeded by PACE (1999 to 2006), which was a regional programme designed to meet country needs and global priorities related to the eradication of rinderpest and the control of other major epidemic diseases of livestock. In particular, PACE was to build on the successes of PARC and continue the campaign for the verifiable eradication of rinderpest. The EU provided EUR 77 million for implementation of PACE from 2000 to 2006 (Agrisystems Consortium, 2006).

In contrast to PARC, PACE was managed and coordinated by AU-IBAR, with 32 participating countries each allocated a portion of the total budget. Within its budgetary limits, each country prepared a five-year global work plan of procurement, training and other inputs. PACE's objectives were to strengthen the technical capacity of disease surveillance and animal health information systems, continue rinderpest eradication, and strengthen the control of other major epidemic diseases. A further objective was to increase livestock farmers' awareness of the benefits of animal health services, including through strengthened linkages between central institutions and farmers.

Following the outbreak of rinderpest in wildlife in the Tsavo National Park in Kenya in 1994, the coordination and integration of disease surveillance in susceptible wildlife were increased during the last phase of PARC and throughout PACE. In 2000, a wildlife surveillance component was established in the PACE Epidemiology Unit, which implemented AWVP in nine priority countries from 2002 to 2003. The *Centre de Coopération Internationale en Recherche Agronomique pour Development* (CIRAD) in France was the contract holder, with a subcontract to the Zoological Society of London. AWVP carried out disease investigation and retrospective sero-surveillance in susceptible wildlife species.

Despite the successes of PACE, there were concerns that residual foci of rinderpest may have remained in the Somali ecosystem, an area comprising southeastern Ethiopia, northeastern Kenya and Somalia. This was the last place where rinderpest had been diagnosed, in 2001. To address these concerns, SERECU was established to ensure that the three Somali ecosystem countries – Ethiopia, Kenya and Somalia – attained rinderpest freedom, and international recognition of it. The project applied an epidemiologically driven strategy and an ecosystem approach, with enhanced coordination and harmonization among the veterinary services of the three countries. The first phase of SERECU was funded through PACE, from January 2006 to February 2007. FAO-GREP and AU-IBAR supported a bridging phase from 2007 to April 2008, and the second phase was funded by the EU for implementation from May 2008 to December 2010 (Massarelli and Hoogendijk, 2010). Implementation of the various rinderpest eradication projects faced several problems: sporadic civil strife and insecurity, notably in southern parts of the Sudan, the Afar Region of Ethiopia, and Somalia, Liberia and Sierra Leone; national veterinary authorities' failure to contain the second



great African pandemic of the early 1980s, owing to limited financial and physical resources; insufficient understanding of the role of wildlife in the maintenance and transmission of rinderpest; the presence of mild strains of rinderpest virus at risk of reverting to virulence; and the institutionalization of mass vaccination, with countries' unwillingness to transit from mass vaccination to surveillance as part of the OIE Pathway for verification of rinderpest freedom.


RICHARD KOCK

Corneal opacity in kudu, Kenya

Several factors contributed to the ultimate success of the whole eradication process, including the PARC initiative of withdrawing vaccination and replacing it with surveillance, which culminated in OIE convening an expert group on rinderpest surveillance systems, in Paris (France) in 1989. The resulting Recommended Standards for Epidemiological Systems for Rinderpest were adopted by OIE as part of Chapter 8.12 of the Animal Health Code, and later became the OIE Pathway. Other critical elements for success were:

- the political support of governments of AU member countries;
- the availability of effective and safe vaccines and reliable diagnostic and surveillance tools, through enzyme linked immunosorbent assay (ELISA) technology for both sero-monitoring and sero-surveillance;
- the decision made during PACE to eradicate all mild rinderpest virus strains, as it was perceived that these could revert to a more virulent form;
- innovative approaches to animal health services delivery, including the use of community animal health workers (CAHWs) and participatory epidemiology techniques, which facilitated access to and elimination of the disease from remote areas affected by political instability, civil strife and insecurity;
- introduction of a thermo-stable rinderpest vaccine, which significantly reduced dependency on a cold chain system and allowed CAHWs to deliver the vaccine to the field and carry out vaccination easily and efficiently;
- capacity building of national veterinary services in Africa, particularly in epidemiology and laboratory diagnosis, including the creation of epidemiological and laboratory networks;
- enabling research, in clarifying that wildlife were not reservoirs for rinderpest virus.

The eradication of rinderpest from Africa and the whole world marks the first time that an animal disease has been wiped off the face of the earth through human intervention. Other achievements from the programme include strengthened capacity of national veterinary services, particularly regarding national and regional capabilities to assess the technical and economic impact of animal diseases and to generate appropriate programmes to control them; creation of a framework for promoting goodwill among governments (especially veterinary departments and research institutes), the private sector, civil society and donors, which is being used for the control of other diseases; strengthened African Union Commission (AUC) institutions – AU-IBAR and the AU Pan African Veterinary Vaccine Centre (AU-PANVAC) – and capacities; positive socio-economic benefits from investments in rinderpest eradication (Tambi *et al.,* 1999; Omiti and Irungu, 2010); improved access to markets and increased regional and international trade in livestock; and improved wildlife conservancy, leading to positive impacts on tourism.

Although rinderpest is now eradicated from Africa, other transboundary animal diseases continue to erode the continent's access to lucrative livestock export markets. Strategies and programmes for the progressive control of these diseases, and continued vigilance for rinderpest re-emergence are necessary. Rinderpest eradication mobilized many organizations and institutions behind a single goal, and could be a key to success for other initiatives. Such collaboration promotes coherent structural changes across various stakeholder groups. The international consensus achieved over the past three years on the prevention of and response to risks at the interfaces among animals, humans and their various environments (the One Health approach) is a natural and logical development of the policy evolution that started with rinderpest control and eradication. The socio-economic benefits of rinderpest eradication have only been partially documented. Despite the cost of such an exercise, it is necessary to document these benefits in full, to provide justification for investing in the control and eradication of other transboundary animal diseases.

The following are among the main lessons learned from AU-IBAR's experience of the rinderpest eradication programme

- Eradication of a disease such as rinderpest is a long-term process (with disease impact diminishing over time). Keeping local and international actors and development partners constantly mobilized against rinderpest was a major challenge for AU-IBAR for more than half a century.
- It is important to maintain donor focus and commitment over the long term. Aid effectiveness is a challenge for programmes with wide geographical coverage and long time frames, such as those for transboundary animal disease control, particularly regarding ownership, alignment, harmonization and coordination.
- Focused strategic vaccination (immuno-sterilization) based on rigorous epidemiological surveillance not only reduced wastage of scarce public funds but also accelerated the eradication of rinderpest.
- Mild strains of rinderpest had to be dealt with, to ensure total elimination of the disease.
- The ecosystem approach, with enhanced coordination and harmonization among the veterinary services of neighbouring countries, proved critical for the eradication of rinderpest.

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The West Asia Rinderpest Eradication Campaign

The West Asia Rinderpest Eradication Campaign (WAREC), a regional UNDP/FAO project (RAB/86/024), was implemented in 11 countries of West Asia, from March 1989 to December 1993. At the time, the total bovine population of these countries was 8 446 000 head: 6 000 in Bahrain; 4 520 000 in Egypt; 1 745 000 in Iraq; 29 000 in Jordan; 26 000 in Kuwait; 52 000 in Lebanon; 136 000 in Oman; 8 000 in Qatar; 724 000 in the Syrian Arab Republic; 50 000 in the United Arab Emirates; and 1 150 000 in Yemen. In WAREC countries, bovines were mostly cattle, except for 2.3 million buffaloes in Egypt, 111 000 in Iraq, and 1 000 in the Syrian Arab Republic.

Rinderpest is known as *al-taun al-baqr* in Arabic, meaning plague of cattle. The earliest records of rinderpest in the West Asian region are from 1827, in Egypt, where a veterinary training centre was established by two French veterinarians, Hamoon and Bruneo, to combat the disease. Since then, rinderpest followed a cycle of approximately 20 years in Egypt, with reappearances in 1842/1843, 1863, 1880 to 1882, 1903/1904, 1912 to 1925, 1945 to 1947, 1950 to 1953, 1958, and 1961 to 1963. In Iraq rinderpest was first noticed during the post-First World War period (1918 to 1923), when the United Kingdom army brought cattle and buffaloes from India for food purposes. Thereafter, the country enjoyed freedom from the disease for six decades. The first epizootic in the Syrian Arab Republic is traceable to the 1920s, and the disease was eradicated by 1934 through quarantine, slaughter and the inoculation of cattle. In Saudi Arabia and Yemen, rinderpest was reported in 1965.

Rinderpest is known as *al-taun al-baqr* in Arabic, meaning plague of cattle

The so-called Near East rinderpest panzootic of 1969 to 1973 engulfed the region, rolling through Afghanistan, the Islamic Republic of Iran and Bahrain from 1969 to 1973, to Turkey in 1970, and on to the Syrian Arab Republic, Lebanon and Jordan from 1971 (Figure 1). During the 1970s and 1980s, rinderpest was reported from all 11 WAREC countries, occasionally from some and more or less continuously from others: Bahrain reported cases in 1976, 1985 and 1988; Egypt in 1982 to 1986; Iraq in 1985; Jordan in 1971; Kuwait in 1971 to 1979, 1980 to 1981, and 1984; Lebanon in 1971 to 1973, and 1977 to 1991; Oman in 1979, 1982, 1984, 1986, 1988, and 1991 to 1993; Qatar in 1987; the Syrian Arab Republic in 1971 to 1974, and 1982/1983); the United Arab Emirates in 1977, 1979, 1984, and 1991 to 1993; and Yemen from 1969 to 1992 (Figure 2).

The WAREC project was launched to combat the disease in this region. It comprised a regional coordination unit, a regional rinderpest laboratory and a data management cell in Baghdad (Iraq), and eight subregional ELISA testing centres in Egypt, Iraq, Jordan, Kuwait, Lebanon, Oman, the Syrian Arab Republic and Yemen. Existing facilities for producing rinderpest tissue culture vaccine (Kabete O strain) in Iraq, the Syrian Arab Republic, Egypt and Jordan, with a total capacity of 15.5 million doses, were strengthened by project funding, as were existing facilities for diagnosing rinderpest by virus isolation, tissue culture and immunological tests in Egypt, Iraq, the Syrian Arab Republic, Yemen, Oman and Jordan. Basic rinderpest diagnostic tools

Figure 1: Near East rinderpest panzootic from 1969 to 1973

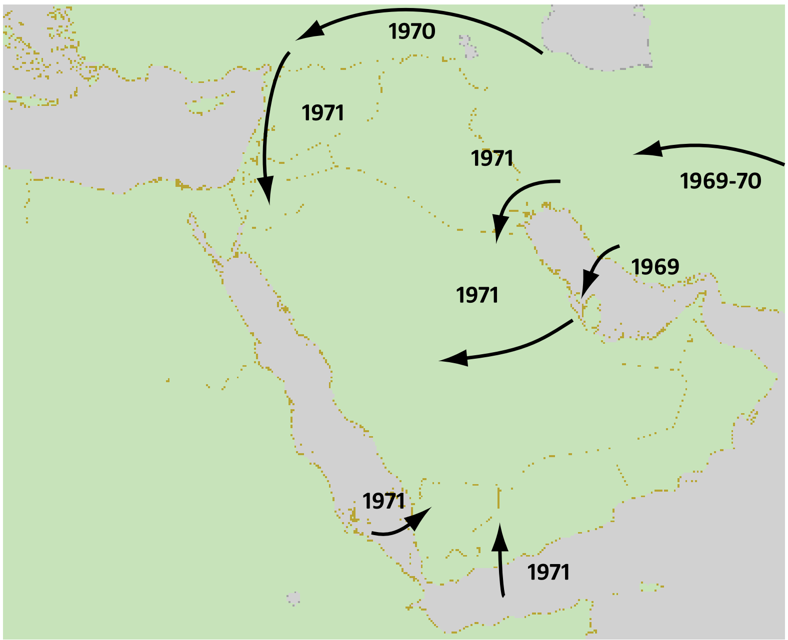
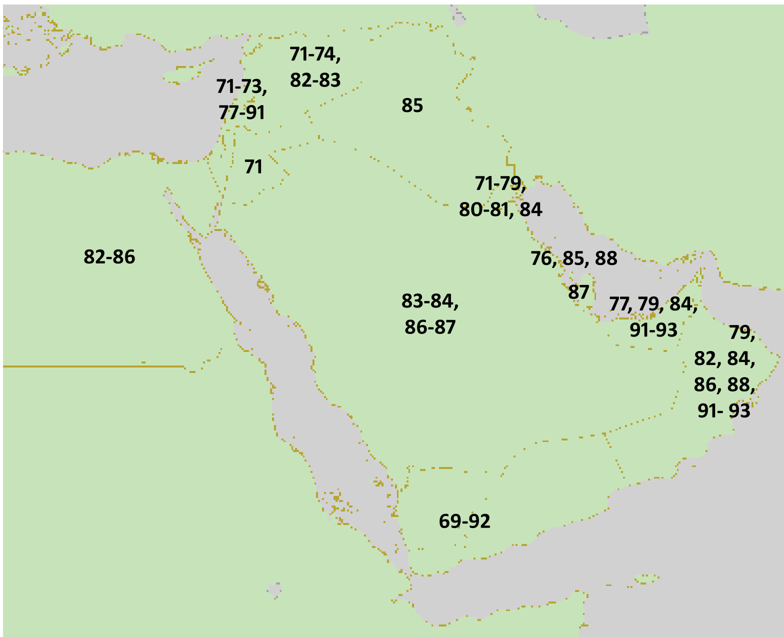
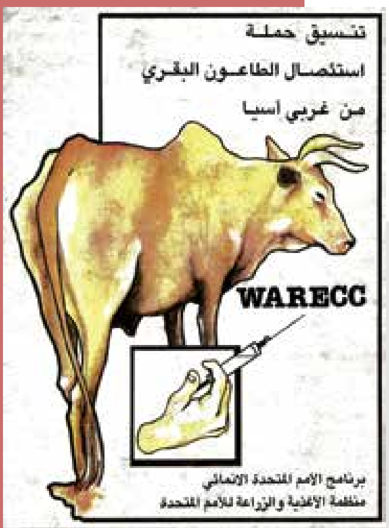


Figure 2: Rinderpest occurrence from 1969 to 1993



were established in national diagnostic laboratories of the remaining five countries. Consultants were engaged and training provided in ELISA testing and sero-surveillance, data management and computer processing, epidemiology, communication, animal quarantine, vaccine quality control and rinderpest diagnosis. Four consultants were engaged, and 187 people were trained. A communication campaign was launched with a WAREC information poster and logo, and diagnostic photo albums and coloured transparency kits were distributed. A monthly WAREC bulletin, *Operation rinderpest*, was published and 65 technical papers were prepared. Separate projects for each country provided details of the schedule for implementing the WAREC technical programme.



WAREC Coordination (WARECC) communication material

Owing to the Gulf War of 1990 to 1991, the regional coordination unit was based at FAO Headquarters in Rome (Italy) in 1991, and then in Amman (Jordan) during 1992 and 1993. In spite of the political polarization between some member countries that followed the Gulf War, all countries remained united in their simultaneous implementation of the WAREC plan.

The region's cattle population included 30 to 40 percent exotic and crossbred dairy cows, which were kept on organized farms, including in Iraq and Jordan, where some dairy colonies had populations of 20 000 to 30 000 exotic cows each. This exotic stock was more susceptible to rinderpest infection than indigenous cattle, which were relatively resistant to the disease. Indigenous cattle were mostly cows, and animals were also used for draught or transport in some countries, such as Egypt. Outside the organized farms, the bulk of the cattle and buffalo population was owned by individual livestock farmers, with an average farmer having a herd of 10 to 15 cows or 15 to 200 buffaloes. Animals were kept loose in cattle sheds and paddocks, and were mostly hand-fed; sometimes they were sent for grazing or wallowing in nearby areas. Dung was removed only periodically from cattle yards, so during disease outbreaks environmental contamination built up and the infection could disseminate quickly within the herd. As buffaloes were rarely tied in West Asia, it was usually difficult to approach or control them for the purposes of vaccination and veterinary aid.

In Yemen, the population was biased towards small ruminants, with an average farmer owning two cows, 14 sheep and 17 goats. Livestock were culturally important as a sign of wealth and were often given as gifts in marriage. In Gulf countries, wealthy people sometimes kept livestock in their orchards as a hobby, in groups of 10 to 30 cattle, 200 to 300 sheep and goats and a few camels. Special efforts were needed to involve these livestock keepers in production livestock programmes. Throughout the region, cattle and buffaloes were not moved on the hoof from one area to another for trading, except in Yemen. In Iraq, for example, farmers transported their stock in pick-up vans or trucks for sale at small cattle markets of 100 to 200 head. Bovine rearing was neither nomadic nor transhumant. There were very few wild bovines in the region.

Most West Asian countries imported cattle and buffaloes for meat, and infection entered through the import of infected cattle, owing to inadequate quarantine procedures in Yemen, Lebanon and the United Arab Emirates. Unrestricted overland movement of animals was responsible for the spread of infection between Yemen and neighbouring parts of Oman/the United Arab Emirates. Refugee movement following the Gulf War of 1991 led to rinderpest spread in areas sharing borders with the Islamic Republic of Iran, Iraq and Turkey. In Lebanon, spread was facilitated by civil disturbances, which made control measures difficult, and the disease became endemic. Rinderpest also became endemic in Yemen.

Most West Asian countries had organized veterinary services provided through government veterinary hospitals, dispensaries, aid centres, mobile units, etc. While traditional veterinary measures have been practised since antiquity, modern veterinary practice is a recent introduction for most countries in the region, except for Egypt, where it was established in 1903. Vaccination work is usually carried out by veterinarians and assistants at government clinics or by specially constituted vaccination teams, but may involve contractors (Oman). In 1992, WAREC countries had a total of 18 135 government veterinarians and 12 787 vaccinators/field assistants to carry out vaccinations, and another 5 162 veterinarians in laboratories and colleges to provide diagnostic support. There were 60 animal quarantine stations in the region: Bahrain had one, Egypt seven, Iraq five, Jordan ten, Kuwait six, Lebanon two, Oman six, Qatar one, the Syrian Arab Republic seven, the United Arab Emirates ten, and Yemen five. Each country had laws for animal quarantine and disease control.

The WAREC project work plan envisaged a preparatory phase (1989 to 1990), a vaccination phase (1991 to 1992) and a surveillance phase (1993). After the preparatory phase, two rounds of mass vaccination of susceptible bovine populations were arranged in 1991 and 1992. As the Gulf War prevented some countries from carrying out mass vaccination in 1991, an additional round of mass vaccination was planned for 1993. On a target bovine population of 8.6 million, 7 million vaccinations were carried out in 1991 (80.7 percent coverage) and 8.3 million in 1992 (95.1 percent coverage); approximately 8.5 million vaccinations were anticipated for 1993 (99 percent coverage). However, the percentage coverage varied among countries in 1991 and 1992 (Table 1).

Table 1: Vaccination coverage, by country

Country	1991	1992
Bahrain	100.0	50.0
Egypt	108.0	114.0
Iraq	45.0	100.5
Jordan	54.2	40.0
Kuwait	0.0	100.0
Lebanon	55.8	23.5
Oman	13.2	31.0
Qatar	14.0	40.0
Syrian Arab Republic	69.8	76.7
United Arab Emirates	82.7	92.3
Yemen	35.6	30.4

The low vaccination coverage in 1991 in Iraq and Kuwait was owing to the Gulf War. In Jordan, lower vaccination coverage in both years was due to a shortage of vaccine, and in Lebanon it was due to lack of budgetary support in the post-war period. The shortfall in these countries was planned to be made up in 1993. In Oman, a vaccination contractor could not be hired in 1991 or 1992, so larger coverage was planned for 1993. Qatar and the Syrian Arab Republic were rinderpest-free, having had good coverage in the past, so did not require higher vaccination coverage than they achieved. Yemen could cover only one-third of the target population each year, owing to a shortage of human resources and budgetary and logistics support; however, it attempted to achieve 100 percent coverage over the three years.

Serum samples from the vaccinated population were tested for the presence of rinderpest antibodies. In 1991 and 1992, about 29 000 serum samples collected from four large countries were tested, and the percentage of immune animals was found to vary from 46 to 91 percent. Wherever the percentage immunity was lower than 65 percent, 100 percent vaccinations were planned for 1993.

The impact of mass vaccination was visible in the progressive reduction of disease incidence. In Yemen, where rinderpest was endemic, the annual average incidence was 200 outbreaks, with 1 000 cases in 1987 to 1989. In 1991, this level was reduced to 33 outbreaks and 92 cases, in 17 subdistricts; from January to September 1992, the level remained static at 35 outbreaks and 84 cases, but the number of affected subdistricts declined to 11; and from October 1992 to September 1993, Yemen remained free from clinical rinderpest. In Lebanon, where major outbreaks in 1989 killed thousands of animals, five outbreaks with 15 cases were recorded in 1991; thereafter, no rinderpest was reported for 1992 or from January to September 1993. In Oman, in 1991, eight outbreaks and 26 cases were reported from two of the eight governorates; in 1992, there were ten outbreaks and 90 cases from two governorates; in March 1993, one outbreak and ten cases were reported from eight governorates; and after March 1993 no outbreaks were reported. In the United Arab Emirates, in 1991, only one outbreak with two cases was reported, and in June 1992 two outbreaks and three cases were reported; in March 1993, one outbreak with nine cases was reported in one governorate, and after March 1993, no incidence was reported. In Iraq, from 1989 to 1992, suspected cases of diarrhoea with stomatitis occurred in 14 of the 18 governorates; after February 1993 no suspected cases were reported.

In summary, no rinderpest occurred in Yemen, Lebanon, Oman, the United Arab Emirates and Iraq for periods that ranged from nine months to two years before the WAREC project terminated. In other countries, rinderpest-free status was maintained: in Egypt from 1990, in Bahrain from 1988, in Qatar from 1987, in Kuwait from 1985, in the Syrian Arab Republic from 1983, and in Jordan from 1972. WAREC therefore achieved control of clinical rinderpest before the end of the project.

Before termination of the project in December 1993, WAREC circulated plans to individual countries. These outlined the clinical, virological and serological surveillance necessary to fulfil the OIE criteria for attaining freedom from rinderpest disease and freedom from rinderpest infection status. As a result of these efforts, some hidden foci of infection were detected across the region. However, rinderpest re-appeared in Oman, the United Arab Emirates and Yemen during the post-WAREC period, with its re-emergence in Yemen probably resulting from imports of infected livestock from the Horn of Africa. The disease was finally controlled in Oman in October 1995, the United Arab Emirates in June 1995, and Yemen by the end of 1995.

Human resources support for WAREC was provided through a UNDP/FAO-funded project coordinator and virologist, and about 36 000 veterinary and para-veterinary personnel in the participating countries worked for the project. The UNDP/FAO funding was about USD 1.75 million, so it is clear that most of the operational expenses were borne by the countries themselves.

The WAREC project also assisted in controlling rinderpest in Turkey from October to December 1991, through FAO TCP projects TCP/TUR/0154 (A) and TCP/TUR/0155 (E). Overlapping the end of the WAREC project, additional funding from FAO was arranged for rinderpest control in Iraq, through TCP/IRQ/2253 (E), and in Lebanon, through TCP/LEB/2254 (E), and for the control of peste des petits ruminants in Jordan in 1993, through TCP/JOR/2354 (E).

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Global rinderpest eradication and the South Asia Rinderpest Eradication Campaign

The idea of the South Asia Rinderpest Eradication Campaign (SAREC) evolved alongside similar campaigns in Africa (PARC) and West Asia (WAREC). In 1983, FAO organized an Expert Consultation on Requirements for the Rinderpest Eradication Campaign in South Asia, which was held in India. Following the consultation, FAO commissioned a team to visit the five countries of Bangladesh, Bhutan, India, Nepal and Sri Lanka to study ongoing activities and identify further requirements for eradication of this serious cattle disease from the region. Based on findings from this visit, a regional project proposal was submitted to UNDP and the EU for funding, but the project did not come to fruition.

PETER L. ROEDER

Cattle in Bangladesh

Meanwhile, the FAO Animal Production and Health Commission for Asia and the Pacific (APHCA) – formed in 1975 and based at the FAO Regional Office in Bangkok – held its annual session, which was attended by senior livestock officials of member countries, including four of the five SAREC countries (Bhutan joined APHCA later, in 2000). During the late 1980s and mid-1990s, a key agenda item at APHCA sessions was how to establish a regionally coordinated campaign for rinderpest eradication in South Asia. APHCA developed and promoted an action-oriented programme for SAREC, including the dissemination of information about the animal movement control and quarantine procedures applicable to the prevailing regional situation, and the organization of a series of training programmes on diagnosis and surveillance for rinderpest eradication in South Asia. The EU provided bilateral assistance to Bhutan, India and Nepal, and with APHCA providing its member countries with the momentum for regionally coordinated disease control activities, the successful eradication of rinderpest in South Asia was assured.

India

Rinderpest was probably first introduced into India around the middle of the eighteenth century. It was first reported from Assam in 1722, Madras in 1848, Calcutta in 1864, Varanasi in 1869, and subsequently in most parts of the country. Efforts to control rinderpest in India were initiated in 1868 with the constitution of a Royal Commission. This recorded outbreaks in sheep in Meerut District in 1866, and in goats in Etawa District in 1867, and farmers' evidence from North-West Frontier Province (NWFP, now in Pakistan), Punjab and Uttar Pradesh in 1871. In the early 1950s, about 400 000 rinderpest cases occurred in 8 000 reported outbreaks a year, resulting in the death of about 200 000 animals from a bovine population of approximately 150 million. The case fatality rate generally observed in outbreaks was 60 percent. Rinderpest also occurred in sheep and goats from 1967, initially in southern states, but later extending into western, central and northern states (although some of these cases were likely to have been peste des petits ruminants); in pigs in three southern states (1976 to 1985); in mithuns (*Bos gaurus*) in Arunachal Pradesh (1981 and 1984); in wild buffaloes in Assam, Andhra Pradesh and Kerala (1982); and in nilgai or blue bulls (*Boselaphus tragocamelus*) in Madhya Pradesh in the mid-1970s. The last confirmed rinderpest outbreak in India was detected in the North Arcot District of Tamil Nadu in October 1995.

Indian Veterinary Research Institute (IVRI), Izatnagar

The constant menace of rinderpest provided impetus for the establishment of civil veterinary departments across the country and the Indian Veterinary Research Institute (IVRI) at Mukteshwar. Initially, the serum-virus simultaneous method was used to vaccinate animals. Later, with development of the goat tissue rinderpest vaccine (GTV), by Edwards at IVRI in 1927, several GTV production centres were established, and GTV was used to control field outbreaks in the predominantly indigenous cattle population until 1964. India's first pilot control project, the National Rinderpest Eradication Programme (NREP), was launched in 1954 in 18 districts of Andhra Pradesh, Karnataka and Maharashtra, and was expanded in 1956/1957 as a mass vaccination campaign of bovines over six months of age, using GTV and with the goal of immunizing at least 80 percent of the bovines in target areas within a period of five years. Initially, Tamil Nadu, Karnataka and Kerala were excluded, as they were free from rinderpest at that time, but they were included later, in 1965/1966. Through follow-up vaccination of newborns and animals that had previously been missed, 73 percent of the population was vaccinated. The number of outbreaks declined dramatically, from 8 156 in 1956/1957, to 960 in 1960/1961, and to about 300 in 1964 to 1966.

In the early 1980s, the Government of India realized that despite the regular mass vaccination of the previous few decades, much higher annual vaccination coverage was necessary to sustain the status quo. A Task Force on Rinderpest was constituted in 1983, to review and to suggest future eradication plans. The task force noted that only eight states had remained rinderpest-free from 1980 to 1983. No particular epidemiological reason could be given to explain the outbreak patterns: Arunachal, Assam, Punjab, Meghalaya, Bihar, West Bengal, Gujarat, Madhya Pradesh, Rajasthan, Tamilnadu and Kerala States had fewer than five outbreaks each; a mid-range of outbreak numbers was reported from Maharashtra (six outbreaks), Orissa (15) and Karnataka (48); while Andhra Pradesh had an average of 116 outbreaks, of which more than 50 percent were in sheep and goats. Based on these outbreak patterns, the task force divided the Indian states into three categories.

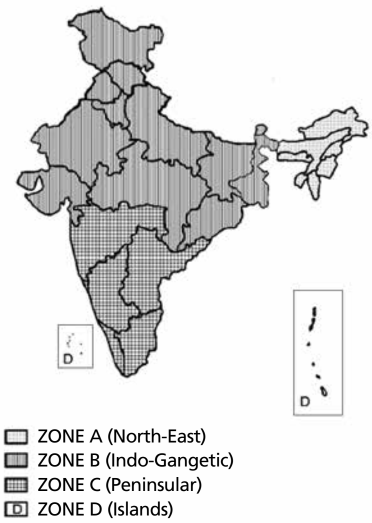
The introduction of a tissue culture rinderpest vaccine (TCRPV) in the 1960s greatly strengthened NREP's efforts, and most state vaccine production units switched to freeze-dried TCRPV production. There was a steady increase in vaccine coverage during the 1980s, with rinderpest outbreaks continuing in the range of 140 to 160 per annum by the end of the decade. In January 1990, given the reasonably low and stable rinderpest situation in the country, the Government of India launched its final thrust campaign – the National Project on Rinderpest Eradication (NPRE), with an outlay of rupees (INR) 4.05 billion: INR 3.41 billion from the government, and 640 million from the EU, as a component of the Strengthening of Veterinary Services in India for Disease Control project (ALA/89/04).

NPRE's components included mass immunization, strengthening of tissue culture vaccine production and diagnostic facilities, vaccine quality control, sero-monitoring, sero-surveillance, mass communication, and training workshops. Research on vaccine improvement and quality control, the epidemiology of rinderpest in small ruminants and the development of diagnostic kits for sero-monitoring, sero-surveillance and differential diagnosis of pest des petits ruminants was also supported. The adoption of a landscape epidemiological approach to eradicating rinderpest, with an appropriate vaccination strategy according to the OIE Pathway, was the keystone for successful implementation of NPRE. India was divided into four zones according to the historical and current epidemiological situation of rinderpest: zone A comprised the seven northeastern states; zone B 21 states in the Indo-Gangetic region; zone C five southern states; and zone D two island territories. This strategic approach benefited from the gains made from more than 40 years of mass vaccination campaigns.

Following the OIE Pathway, zones A and D were declared (Figure 1) provisionally free from rinderpest in 1994, followed by zone B in 1996, and zone C in 1998. The second stage in the OIE Pathway, freedom from rinderpest disease, was declared for zone A in 1998, and for zones C and D in 2001. Although mass vaccinations in all the 21 states of zone B stopped on 1 March 1998, vaccinations continued in a 30-km belt bordering Pakistan in the three states of Punjab, Rajasthan and Jammu and Kashmir, until March 1999, July 2000 and October 2000 respectively. Consequently, 18 states in zone B attained freedom from rinderpest disease status in March 2001, with Punjab following in April 2002, Rajasthan in July 2003, and Jammu and Kashmir in October 2003. The third stage in the OIE Pathway, freedom from rinderpest infection, was executed in three phases for three consecutive years, from November 2001 to October 2004, following a rigorous rinderpest sero-surveillance programme in all four zones.

The ELISA Testing and Data Management Center at the Project Directorate of Animal Disease Monitoring and Surveillance in Bangalore designed the modality for stratified random sampling. The whole country was divided into three strata based on the epidemiological pattern of rinderpest described by the Task Force on Rinderpest in 1983, with the objective of achieving 95 percent probability of detecting 1 percent prevalence of rinderpest among herds (villages) and 5 percent prevalence within a herd (village). In all three phases, the 100 percent target for village sampling was achieved: with 74 178 cattle, 34 236 buffaloes, 12 546 sheep and 54 556 goats sampled in 3 866 villages. As well as sero-surveillance, states tested bovine stomatitis/enteritis cases; NPRE created a national network of 33 state-level rinderpest ELISA laboratories and 417 rinderpest vigilance units, which operated as check posts for regulating animal movements. The overall sero-conversion was more than 70 percent by the end of the national vaccination campaign in 2000.

Figure 1: Zoning in India



Source: OIE.

Based on a dossier of evidence, OIE declared India free from rinderpest infection in 2003. The total cost of the vaccination campaign from 1955 until 2000 was nearly INR 1 668 billion (USD 33.36 billion). India has constituted a high-level National Animal Disease Emergency Committee to combat rinderpest immediately, should it re-emerge. At the state level, state animal disease emergency committees have been established, with a state rinderpest officer and supporting units functioning at the divisional level. A stockpile of 1.5 million doses of vaccine for emergency deployment within 24 hours is available; master stock of TCRPV vaccine seed virus is deposited at IVRI; NPRE has ensured that there are no potentially infected/virulent samples within the country, and rinderpest research is not allowed. State authorities have been instructed to report any suspected case of rinderpest immediately to the Government of India, and to initiate immediate zoo-sanitary and containment measures. The National Animal Disease Control Act (2009) will be enforced in the case of an emergency.

India has implemented long and arduous campaigns to achieve rinderpest eradication, through focused and committed approaches at central and state agencies, the coordination and monitoring of field operations, the mobility of field staff, vaccine quality control, the establishment of cold chains, sero-monitoring and sero-surveillance, and essential political and administrative support. The success of India's NREP was a critical step towards the achievement of rinderpest control and eradication in the rest of South Asia.

Pakistan

Although Pakistan only came into existence in 1947, familiarity with rinderpest extended back over several centuries (Chaudhry and Akhtar, 1972). In 1947, rinderpest broke out owing to the large-scale livestock movements that took place at the time of independence (Khan, 1991), but the situation had been brought under control by 1950, through massive vaccination coverage. In the mid-1950s, the disease re-entered several districts of Punjab from India, and was finally controlled by 1961/1962. From 1958 to 1962 (Qureshi, 1972), outbreak reports from NWFP suggested that hundreds of thousands of animals had died (Raja, 1996), but there were no official statistics. Over the decade 1962 to 1972, the incidence of rinderpest was greatly reduced owing to a nationwide prophylactic vaccination campaign using live attenuated goat tissue and live attenuated lapinized vaccines that were believed to provide three years of immunity. Despite this large-scale vaccination, outbreaks occurred in Balochistan in the autumn of 1967 (Ali and Babar, 1987) and in the Swat District of NWFP in 1970. In 1958, rinderpest entered the Landhi Cattle Colony (LCC) of Karachi District, Sindh Province. Thousands of cases were seen every year, mostly during the winter. Localized outbreaks were reported from elsewhere in the country, including one in the autumn of 1987 in and around Quetta, and others in 1991 (Taylor, unpublished observations) and 1995 (Hussain *et al.*, 2001).


PETER L. ROEDER

Buffalo market, NWFP, Pakistan

The dairy cattle colonies around Karachi and Hyderabad drew constant supplies of replacement cattle and buffaloes from the interior districts of Sindh and Punjab Provinces. At the end of their lactation, most of these animals were slaughtered locally to meet the high demand for meat in the Karachi metropolis, but an increasing proportion were returned to the districts for repeat breeding. In LCC, 9 000 cases were recorded in 1969, and an annual average of 4 700 cases were observed from 1970 to 1974. The annual mortality rate dropped after 1975, when the Veterinary Research Institute (VRI) at Lahore started to manufacture TCRPV but in 1984 rinderpest was still killing about 700 cattle a year in LCC. Under a UNDP programme, FAO carried out a retrospective examination of the rinderpest cases reported by the LCC veterinary hospital from July 1983 to June 1984. This study showed that the virus was present in LCC throughout the year, but was more common in the winter months. In 1993, any local optimism that rinderpest was no longer causing outbreaks in LCC was dashed when the presence of the virus was confirmed by the World Reference Laboratory at Pirbright in the United Kingdom.

Although infected animals from Sindh endemic areas were probably occasionally traded in neighbouring Punjab Province, Punjab was never endemically infected, according to participatory disease search (PDS) interviews with village livestock farmers. Sindh Province was most likely the ultimate source of infection for outbreaks near Lahore in 1994 and in Rawalpindi in 1997 (Hussain, Haq and Naeem, 1998).

In March 1994, presumably through the transport of infected livestock by road, rinderpest broke out in the Northern Areas (NA) (Rossiter *et al.*, 1998). Escalating in virulence to reach an 80 percent mortality rate in cattle and nearly 100 percent in yaks and yakmos (a yak-cow hybrid), within a short period the virus was responsible for the deaths of some 40 000 bovines in NA. FAO provided an expert mission in less than a week to confirm the diagnosis. After confirmation, the EU, FAO and Italy implemented a series of emergency control projects (four FAO TCP projects, two EU projects on rinderpest, and an Italian project on transboundary animal diseases). Emergency rinderpest vaccination by the NA Department of Livestock Services began in August 1994, using vaccine manufactured by VRI, Lahore, but this could not eliminate the virus. In 1995, vaccination was repeated with imported vaccines, and with support from the EU and FAO. This second round of vaccination was apparently successful, and no further outbreaks were reported in NA after November 1995. Through implementation of these projects, diagnostic capabilities were enhanced at the district, province and federal levels, foreign manufactured vaccines were procured, the PDS system was set up, national veterinary laboratories were upgraded, and epidemiological units were established in all provinces.

From 1975, routine rinderpest vaccination was conducted using rinderpest vaccine available from VRI, Lahore. Vaccine was distributed annually, in accordance with the demands of the district veterinary authorities, which were responsible for its administration. It was most needed in Sindh, where it took seven years to achieve cumulative vaccination numbers that equalled the total number of livestock. Nevertheless, the judicious use of vaccine succeeded in breaking the transmission chain within the interior of this province. A massive uptake of vaccine in Karachi in 1989 to 2000 probably ensured that any rinderpest reaching the district did not become established or recycled. Further evidence was provided through the PDS programme, funded by FAO and operational from 2003 to 2005. Under this programme, departmental officers trained in PDS techniques visited all provinces covered by the Village-Based Active Disease Search Programme (Mariner *et al.*, 2003). No clinical evidence of rinderpest was found. A total of 10 352 of Pakistan's 75 702 villages were visited: 1 088 out of 1 644 villages in Azad Jammu and Kashmir; 888 out of 7 586 in Balochistan; 110 out of 150 in Islamabad Capital Territory; 823 out of 566 in NA (some villages were visited twice); 1 328 out of 14 325 in NWFP; 2 973 out of 26 174 in Punjab; and 3 142 out of 25 000 in Sindh.There were no official reports of rinderpest for three years after 1997. Although indirect evidence from Karachi and Quetta pointed to the existence of endemic foci in interior districts of Sindh throughout the 1980s and 1990s, the epidemiology was poorly understood. Most of the reported outbreaks were from Karachi, although outbreaks were occasionally reported in other districts. In spite of PDS evidence suggesting a possible continued rinderpest presence in Thatta District, Sindh Province, the absence of an official report for three years prompted the (premature) conclusion that rinderpest had died out in Pakistan (Hussain *et al*., 2001). However, the last outbreak in Pakistan was in 2000, on a farm at Memon Ghot Township, Karachi District, Sindh Province. This outbreak was discovered and confirmed due to heightened surveillance, supported by FAO, and was eliminated accordingly. Rinderpest was never again confirmed in Pakistan.

From 1975, routine rinderpest vaccination was conducted using rinderpest vaccine available from VRI, Lahore

As vaccination had ended in 2000, a population of rinderpest-susceptible animals was available for sampling by 2003. To obtain serological proof of final rinderpest eradication, more than 70 000 animals nationwide were sampled during 2003, 2004 and 2006, and tested using the OIE-approved, rinderpest competitive ELISA. For the sake of completeness, a similar data set was developed from 30 000 small ruminant sera with no indication of rinderpest virus in the population. None of these surveys found any incidence of positive rinderpest samples above the non-specific threshold.

In the light of these findings, a dossier of evidence was prepared and submitted to OIE in 2006. Accordingly, after approval from the International Committee of OIE, Pakistan gained entry to the OIE list of rinderpest-free countries in May 2007. Ultimate success was the result of transparent reporting of the presence of rinderpest in NA during 1994, emergency and follow-up support from FAO, EU support in providing high-quality vaccines, and federal and provincial livestock departments' efforts in implementing the various initiatives for rinderpest eradication. Prior to this, the FAO Animal Production and Health Commission for Asia and the Pacific, in Bangkok (Thailand), had persistently encouraged member countries, including Pakistan, to develop and launch national rinderpest control projects/programmes to achieve the targets for rinderpest eradication set by GREP. All the facilities, systems and awareness that emerged within the veterinary and livestock communities helped finally to eradicate rinderpest from Pakistan.

Other South Asian and neighbouring countries

Bangladesh

There were an estimated 5 million susceptible animals in border areas

Although the last recorded rinderpest outbreak was in 1958, because of the large number of cattle migrating from India to Bangladesh for slaughter, the following control measures were put in place: creation of an immune belt along the border, with regular vaccination, including of calves from three months of age, and revaccination within 12 months; routine vaccination of the susceptible population along the highway used to transport animals from border areas; and targeted vaccination in strategic areas. There were an estimated 5 million susceptible animals in border areas, and 2 million along the highway leading to large cities such as Chittagong and Dhaka. To meet the demand for large numbers of quality vaccine doses, a vaccine production centre was established in 1984 with support from the Asian Development Bank (ADB). In 1991/1992, annual production of goat tissue vaccine and tissue culture vaccine was 10.7 and 2.4 million doses, respectively. Over time, vaccine production shifted from goat tissue to the more reliable tissue culture vaccine; village-level veterinary personnel were significantly enhanced through training; and one central and nine district disease investigation centres were established to facilitate the prompt diagnosis and reporting of the disease nationwide. Vaccination ceased in 1999, and Bangladesh was declared officially free from rinderpest in 2010.

Bhutan

The last recorded outbreak was in 1969. Bhutan became a member of OIE in 1991, and declared itself free from rinderpest. Under the EU-funded Strengthening of Veterinary Services for Livestock Disease Control project, implemented in 1992, Bhutan's disease reporting, surveillance and diagnostic facilities were strengthened. A network of rinderpest vaccine stock was established at all zone (equivalent to district) veterinary laboratories, to meet the emergency requirements for a possible outbreak of rinderpest. Bhutan was declared officially free from rinderpest in 2005.

Myanmar

Although the last outbreak of rinderpest in Myanmar was in 1957, to prevent re-introduction of the disease, the country continued its vaccination programme along the international border in Rakhine State, Kachin State, Sagaing Division and Shan State, until 1994. With initiation of the OIE-supported Southeast Asia Foot-and-Mouth Disease Control Project and the FAO Greater Mekong Transboundary Animal Diseases Project, subregional collaboration and cooperation on disease control measures were strengthened, including through improved understanding and information exchange on the cross-border movement patterns of large ruminants. These epidemiological developments contributed to the overall understanding of transboundary animal diseases in Myanmar, and supported the OIE declaration of the country's freedom from rinderpest infection in 2006.

Nepal

Nepal can be divided into three broad agro-ecological zones – Mountain, Hill and Terai (the Indo-Gangetic plain area) – and five regions: Eastern, Central, Western, Mid-Western and Far-Western. Rinderpest was first recorded in 1939, in the Kathmandu Valley (Hill zone), Central Region; the second outbreak was recorded in 1953 in the Pokhara Valley (Hill zone), Western Region. A serious outbreak occurred in Birganj (Terai zone), Central Region in 1954/1955. The outbreaks in the 1950s were brought under control by vaccination. FAO fielded an expert, who recommended the creation of an immune belt about 800 km long and 25 to 30 km wide, along the border with India; the establishment of internal check posts between the Terai and Hill zones; and capacity building in animal health. Severe outbreaks occurred in 1963/1964 in four districts in the Terai and one district in the Hill zone of Central Region, and from 1965 to 1969 in 26 districts, mostly in Far-Western and Mid-Western Regions and involving all ecological zones (Terai, Hill and Mountain). With the support of FAO, the EU and ADB, a mass vaccination programme was implemented. In 1964, FAO provided technical assistance for establishing a veterinary laboratory to produce rinderpest vaccine in Nepal, and the disease was brought under control. In 1973, rinderpest reappeared in eight districts in three regions, all in the Terai zone. The government continued to maintain the immune belt through regular vaccination. Rinderpest cases were reported in Kathmandu Valley (Hill zone), Central Region in 1984 and 1986, both in imported animals. An outbreak was also observed in Kailali District (Terai zone), Far-Western Region in 1986. These outbreaks were brought under control through ring vaccination and movement control. The last rinderpest outbreak was in 1990, and OIE recognized Nepal as free from rinderpest infection in 2002.

Sri Lanka

Sri Lanka was free from rinderpest for four decades from 1946 until its reappearance in 1987, in Eastern Province where civil disturbance persisted. A shipment of goats brought in by the Indian peacekeeping force was widely recognized as the source of infection. Mass vaccination was initiated in 1988, and as Sri Lanka did not have its own rinderpest vaccine production facilities, it had to import all the vaccine required, mainly from India. In 1988, a total of 638 000 vaccinations of cattle, buffaloes and small ruminants were carried out, representing coverage of 51.5 percent of the target livestock. The last vaccination was in 1997. OIE recognized Sri Lanka as free from rinderpest infection in January 2011.

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East and Southeast Asia

In the then Union of Soviet Socialist Republics (USSR), the last rinderpest outbreak was in 1928 (FAO/OIE/WHO, 1990). The USSR maintained a vaccination zone along its border to protect the country from reintroduction of rinderpest. The USSR developed the K37/70 rinderpest vaccine, based on the 1961 Kabul isolate using primary calf kidney cells. This vaccine was regarded as safe for cattle and yaks and was widely used (Roeder and Rich, 2009). During the dissolution of the USSR, rinderpest re-emerged in December 1991, in yak in Mongun-Tayga District, Tuva Republic. This outbreak was rapidly controlled through quarantine, vaccination, and restrictions on the movement of animals, animal products and feedstuffs. The last outbreak of rinderpest in the Russian Federation was in 1998, in Amur Region (OIE archives, 1998).

Yak in Mongolia

In Mongolia, information on the control measures applied by the then Mongolian People's Republic are not easy to obtain, but the last outbreak of rinderpest was in 1935. A study indicated that rinderpest had most frequently been introduced into the country by infected Mongolian gazelles (*Procapra gutturosa*) during their migrations across the border with China (Roeder and Rich, 2009). In 1941, an attenuated rinderpest virus (lapinized by Nakamura) was used safely and effectively in Mongolia, unsupported by serum. From the 1950s, the country remained free until July 1991, when a locally restricted outbreak occurred in a transhumant herd in Bayan-Uul District bordering the USSR by the Onon River (OIE archives, 1991). This outbreak was rapidly controlled and was the last rinderpest outbreak in Mongolia.

In China, rinderpest persisted until after the Second World War. Fengtian Veterinary Institute and its Harbin Branch were established in 1925 and 1944 respectively, and produced rinderpest-immune serum to create an immune belt along Inner-Mongolia Region. After the Second World War, first the United Nations Relief and Rehabilitation Administration and then FAO supported China's rinderpest vaccine production based on lapinized Nakamura III vaccine and avianized vaccines developed at Grosse Isle in Canada. The lapinized vaccine was further adapted in sheep and used for rinderpest eradication in China (Barrett, Pastoret and Taylor, 2006). The last rinderpest outbreak in China was in 1955 (FAO/OIE/WHO, 1995). In Taiwan Province of China, rinderpest was present in the north in the nineteenth century, and spread to the south by 1899. The production of immune serum to control rinderpest was started in 1905. The last outbreak in Taiwan Province of China was in 1950, in buffaloes, and was due to infection from imported pigs.

The Korean Peninsula repeatedly experienced rinderpest invasion from neighbouring countries until the twentieth century. From 1911, immunization with the serum-virus simultaneous inoculation method was conducted in border areas in the north. In 1922, Kakizaki vaccine production was started at the veterinary laboratory in Busan, for vaccinating cattle along the border; later, Nakamura's lapinized-avianized vaccine was used to protect cattle. The last outbreaks were in 1931 in the Republic of Korea, and in 1948 in the Democratic People's Republic of Korea (Yamanouchi, 2009).

In Japan, rinderpest outbreak records can be found as far back as the seventeenth century. In the twentieth century, several rinderpest vaccines were developed: Kakizaki vaccine (glycerine-inactivated) in 1918; Nakamura III vaccine (lapinized) in 1941; and chicken embryo vaccine (lapinized-avianized) in 1953. Japan's last rinderpest outbreak was in 1924. After the Second World War, in 1948, FAO and the United Kingdom co-organized the Nairobi Rinderpest Meeting in Kenya, where the existence of the Nakamura vaccine was reported; the vaccine was later distributed to other countries (Yamanouchi, 2009).

Similar to China, the Indochina Peninsula also experienced the presence of rinderpest until after the Second World War. In 1949, the FAO Rinderpest Conference for Asia and the Far East was held in Bangkok (Thailand) to coordinate and take all possible steps for controlling rinderpest outbreaks in Asia (Hambidge, 1955). In 1948, FAO assisted Thailand's establishment of vaccine production using lapinized seeds brought from China and adapted to pigs. The disease was brought under control in Thailand, where the last rinderpest outbreak was in 1957, although mass vaccination along international borders, using locally produced tissue culture vaccine, was conducted until 1995.

FAO/K.PRATT

Ploughing rice paddy field with water buffalo, Cambodia

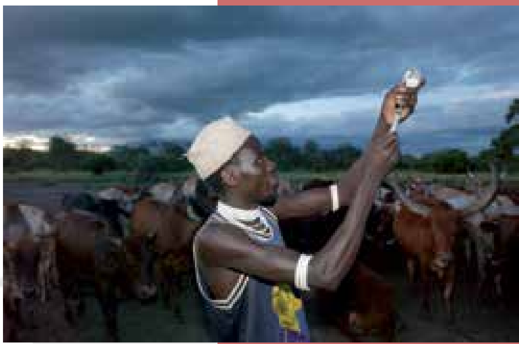
In Cambodia, rinderpest control had been conducted since the 1920s. In 1958, USAID started a vaccination campaign using a killed vaccine, which was expanded throughout the Colombo Plan, using a Nakamura lapinized vaccine produced by the Institut Pasteur in Cambodia. The last rinderpest outbreak in Cambodia was in 1964, while the last outbreak in Lao People's Democratic Republic was in 1966. In Viet Nam, a killed vaccine developed in France was initially used to control the disease; a Nakamura lapinized vaccine was introduced in the 1950s; and Viet Nam requested technology transfer for avianized vaccine production in 1971 (Yamanouchi, 2009). The last outbreak in Viet Nam was reported in 1977.

The last rinderpest outbreaks in Indonesia, Malaysia and Singapore were reported in 1907, 1924 and 1930 respectively. In the Philippines, inactivated vaccine was used to control rinderpest in the early twentieth century, and the disease had disappeared by 1936. The last rinderpest outbreak was in 1955, in imported buffaloes, and was detected during quarantine, so the herd was destroyed and the outbreak contained (Spinage, 2003).

Contributor: Akiko Kamata (FAO)

The role of the African Union Pan African Veterinary Vaccine Centre (AU-PANVAC) in rinderpest eradication

Background



FAO/GIUSEPPE BIZZARRI

Vaccination in a village in the United Republic of Tanzania

PANVAC originated in 1986 in response to the need for effective control of rinderpest in Africa. Earlier attempts to eradicate the disease through the multi-national JP15 had failed in the 1970s, partly because insufficient levels of immunity were sustained in vaccinated animals, owing to the use of vaccines that had not been certified by independent quality control.

This failure prompted the then OAU (now the AU) to request FAO's assistance in setting up a system for independent quality control of the rinderpest vaccines used in the campaign. Initially, this was achieved through a short-term FAO TCP project in 1986, which established two regional vaccine quality control and training centres: one in Dakar (Senegal) for Central and Western Africa; and one in Debre Zeit (Ethiopia) for Eastern and Southern Africa (TCP/RAF/6767). These centres operated from 1989 to 1992 under a project funded by UNDP; in 1993, they were merged into PANVAC, hosted by the Ethiopian Government at the National Veterinary Institute (NVI), Debre Zeit. PANVAC's mandate was to perform quality control on priority vaccines (primarily rinderpest and contagious bovine pleuropneumonia), according to international standards; promote the adoption of biological standardization and control of veterinary vaccines in Africa, through establishment of a repository of characterized reference vaccine materials; develop internationally recognizable quality control criteria; and promote the principles of good manufacturing practice.

PANVAC's contributions

PANVAC's greatest impact on the global rinderpest eradication campaign was in improving the quality of the rinderpest vaccine used in the field. A total of 193 batches of rinderpest vaccine from all the vaccine producing laboratories in Africa were tested between 1996 and 1998, and it was found that the strict, standardized quality control of rinderpest vaccines initiated by PANVAC had resulted in significant improvements in the quality of the vaccines applied. The proportion of African vaccine lots meeting international quality standards rose from about 33 percent in 1985 to more than 90 percent in 1997. Implementation of the quality assurance system enabled managers of PARC to insist that only PANVAC-certified vaccines were used in national rinderpest eradication programmes. At one point, possession of a PANVAC quality assurance certificate was a prerequisite for any rinderpest vaccine purchased for use in Africa or any country where the battle against rinderpest was being waged. Vaccine production and quality assurance technologies based on the PANVAC quality assurance procedures were transferred to countries in other regions, such as Pakistan, India and Iraq. It was noted that these transfers, carried out by PANVAC staff in 1995, may have been decisive in eliminating rinderpest from the countries concerned.

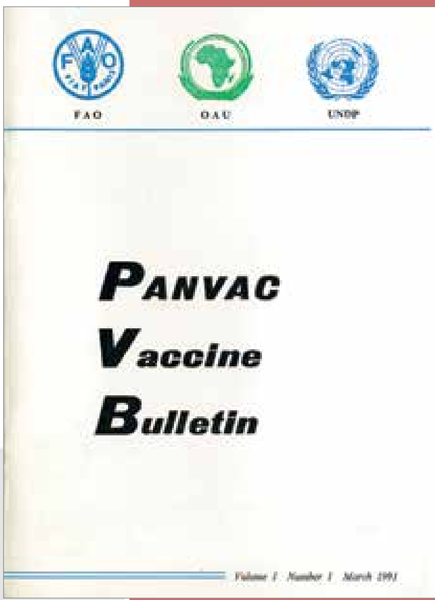
PANVAC's activities throughout PARC were not restricted to laboratory processes to ensure that vaccines released for the campaign were of good quality.

PANVAC was also active at the producer level, promoting the concept of good manufacturing practices, in training laboratory personnel and in the following activities:

- *Standardization of biologics and standard operation procedures:* A repository of well-characterized reference materials was established, comprising cell lines, virus and bacterial vaccine seed stocks, antisera and antigens. Most vaccine production laboratories in Africa have benefited from supplies derived from these materials. Standard operating procedures for the production and quality control of major vaccines were published, and contributed to the adoption of harmonized procedures in Africa.
- *Training and technology transfer:* PANVAC trained more than 400 veterinarians and technicians from national vaccine production laboratories in Africa. The training sessions were organized as workshop fellowships or in-house arrangements. PANVAC also provided technical expertise to vaccine producing laboratories, to improve their productivity. It pioneered the development of an alternative method for preparing thermo-tolerant peste des petits ruminants vaccines, and this technology was transferred to Ethiopia's NVI and Mali's *Laboratoire Central Vétérinaire* (LCV), through FAO TCP support. Representatives from veterinary laboratories in Cameroon, Egypt and Kenya also benefited from knowledge of this vaccine technology, during a workshop organized in April 2003 at Debre Zeit (Ethiopia).
- *Countries that did not produce vaccines,* such as Burundi, the United Republic of Tanzania and Uganda, benefited from PANVAC assistance in revalidating the potency of their priority vaccine stocks and emergency vaccine banks. PANVAC is still involved in the periodic testing of emergency vaccine stock for AU-IBAR. Within the framework of GREP, batches of rinderpest and peste des petits ruminants vaccine from production units in Jordan, the Syrian Arab Republic and India were tested at PANVAC. Senior staff of these laboratories benefited from PANVAC training programmes in quality control and production.
- *Information collection and dissemination:* While UNDP funding continued, PANVAC published a quarterly bulletin on vaccine technology and science, which it distributed to network laboratories.
- *A network of vaccine production laboratories:* PANVAC's quality control services and supply of biological material led to the creation of a network of vaccine production laboratories throughout Africa and the Near East. This network brought benefits to member laboratories.
- *Collaboration with other centres of vaccine sciences:* PANVAC built collaborative partnerships with leading global institutions in vaccine science (IAH-Pirbright, CIRAD-EMVT, CTVM-Edinburgh, NVSL/APHIS/ VS/USDA, IAEA, ILMB/

UC-Davis, etc.) and participated in international working groups such as the OIE working group on veterinary drug registration and the FAO/AU-IBAR/OIE/IAEA consultative group on contagious bovine pleuropneumonia.

PANVAC's contribution to the success of PARC was noted by various evaluation and review teams, who reported that "The success of … PARC and PACE clearly demonstrated that no amount of vehicles, syringes, trained personnel, communication materials would have eliminated rinderpest if the vaccine batches used were of poor quality. It was the secondary and independent level of quality control assessment assured by AU-PANVAC which played a major role in this success and led at the same time to a sustained improvement in the quality of vaccines against rinderpest and contagious bovine pleuropneumonia produced in Africa".



To strengthen these achievements in the interests of Africa, the 67th ordinary session of the OAU Council of Ministers (Addis Ababa 23 to 27 February 1998) decided to make PANVAC an OAU Specialized Agency. AU-PANVAC was officially launched as a specialized Regional Technical Centre of the AU under the Department of Rural Economy and Agriculture on 12 March 2004.

Following the eradication of rinderpest, AU Member States have given AU-PANVAC the mandate to collect and safeguard all materials containing rinderpest: AU-PANVAC is currently concluding talks on the modalities for implementing this activity, and has concluded the arrangements for acquiring a biosafety level-3 laboratory for the purpose. According to its mandate, AU-PANVAC is to serve as the only repository for rinderpest materials and emergency vaccine stock for the event of an outbreak of rinderpest on the African continent.

Contributor: Karim Tounkara (Director AU-PANVAC), Nick Nwankpa (AU-PANVAC) and Charles Bodjo (AU-PANVAC)

An end to cattle plague: laboratory capacity building to support the Global Rinderpest Eradication Programme

The International Atomic Energy Agency (IAEA) was established in 1957 as the world's "Atoms for Peace" organization within the United Nations system. It currently has 151 Member States (March 2011) and works with partners worldwide to ensure the peaceful, safe and secure use of nuclear technologies. In 1964, IAEA and FAO established the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, to help countries apply nuclear science and related technologies for sustainable agricultural development. Through the concerted efforts of IAEA's Department of Technical Cooperation, the Joint FAO/IAEA Division and cooperation with FAO, IAEA helps Member States to develop sustainable capacities in nuclear science and related technologies, including by providing the training and analytical laboratory services necessary for the efficient and safe use of these technologies. Building on this experience, about 25 years ago, IAEA started to collaborate with FAO, OIE, OAU (now AU) and other regional organizations in Africa and Asia to support international efforts to diagnose, control and eradicate rinderpest.


AKIKO KAMATA

FAO/IAEA Division of Nuclear Techniques in Food and Agriculture - Animal Production and Health Laboratory, Seibersdorf, Austria

For centuries, rinderpest was one of the most dreaded livestock diseases. Its devastating effect on European cattle populations in the eighteenth century resulted in the first veterinary school, established in 1761 in France to educate veterinarians on the control of rinderpest and other animal diseases. Some 250 years later, the veterinary profession is set to declare the global eradication of rinderpest.

During the nineteenth century, the application of quarantines helped keep rinderpest at bay, resulting in its eradication in Europe. In parallel with this, the development of vaccination strategies enabled containment of the disease in other regions, but it took until the early twentieth century to develop a standardized goat-adapted rinderpest vaccine. This vaccine was widely used for the control of rinderpest in Asia and Africa in the 1950s and 1960s, until it was replaced by the tissue culture-adapted vaccine, which was both more efficient and easier to produce.

Rinderpest had crippled cattle production in Africa since its introduction during colonial times. The first controlled and well-coordinated campaign, JP15, covered 22 African countries and ran from 1962 to 1976. Based on vaccination coverage only, it demonstrated that rinderpest could be eliminated from the continent, despite the high traffic of animals. JP15 succeeded in eliminating rinderpest from Africa, except for in two small foci, one in western and one in eastern Africa, where the disease persisted, owing to remoteness, lack of suitable diagnostic tools, dependence on a cold chain for vaccine delivery, and inadequate veterinary infrastructure.

Rinderpest re-established itself over much of sub-Saharan Africa in the early 1980s, as a result of the cessation of vaccination combined with increased animal movements. This re-emergence wiped out the previous success of JP15's 15-year vaccination campaign.

PARC, which started in 1987, was the second internationally driven rinderpest campaign coordinated by AU-IBAR. Building on lessons learned from JP15, it was clear that the international community and national authorities had to: i) monitor the impact of the vaccination campaign, by looking at animal immune responses through unbiased, random sero-monitoring activities; and ii) implement proactive measures, such as targeted disease surveillance, to track down any circulating virus. At this stage, the assays used in diagnostic laboratories for rinderpest diagnosis consisted of virus isolation, virus neutralization, agar gel immunodiffusion, and the serum neutralization assay for evidence of protective antibodies. These tests were difficult to perform on large numbers of samples, because they required advanced tissue and virus culture technologies that were heavily dependent on electricity, took up to a week to show results, and required technical expertise to analyse.


FAO/F.PALADINI

Cattle vaccination in Kenya

It was therefore clear that PARC, the other regional programmes within EMPRES-GREP and, later, PACE required a new generation of high-throughput platform, compatible with the prevailing diagnostic laboratory conditions in these countries. Following the recommendations of an international consultative group, the Joint FAO/IAEA Division's Animal Production and Health Section changed the focus of its animal health activities and began to develop programmes for promoting the new nuclear-related ELISA technology (based on the radio immunoassay platform, but omitting radio isotopic tracers) for the diagnosis, monitoring and surveillance of livestock diseases. This technology offered a great advantage to veterinary diagnosticians charged with detecting and monitoring rinderpest and other infectious diseases, such as foot-and-mouth disease or brucellosis. The ELISA technology was accurate, relatively simple to implement and use, and lower-cost than the alternatives. ELISA allowed large numbers of samples to be tested in a relatively short time, with quantifiable results suitable for automatic analysis. It could also be applied for the detection of both the pathogen's antibodies and its antigens.

The ELISA platform was therefore ideally suited to the diagnostic needs of PARC and successive rinderpest eradication programmes. Just before the start of PARC, an ELISA test for the detection of rinderpest antibodies was developed at the Animal Virus Research Institute, the forerunner to today's IAH at Pirbright in the United Kingdom. The prototype ELISA was first validated in 1986/1987 in selected countries, and was quickly adapted into a kit format incorporating quality assurance tools such as positive and negative control samples and pre-coated ELISA plates, which took into account its "fitness for purpose" (sero-monitoring) and the needs of the diagnostician. During implementation of PARC, an ELISA for rinderpest virus detection and its differential diagnosis from the related peste des petits ruminants virus was developed by CIRAD in France. The Joint FAO/IAEA Division ensured the validation of the antibody detection ELISA, and its wide distribution through the IAEA and FAO technical cooperation departments, together with capacity building workshops, follow-up to ensure quality control, and analysis involving laboratory personnel, epidemiologists and campaign managers. The transfer and efficient use of the ELISA platform during the campaigns were made possible by Joint FAO/IAEA Division and IAEA Technical Cooperation Department mechanisms.

In preparation for PARC, consultations with veterinary officials in many affected countries, visits to national veterinary laboratories and discussions with their staff had revealed that many laboratories were unable to provide either the quality or the level of services required to support field programmes directed at controlling livestock diseases. Diagnostic performance was enhanced by the development and distribution of handbooks describing the technical prerequisites for assays and laboratories, and of computer software for managing large data sets, supporting the evaluation of test results and quality control, and carrying out the epidemiological calculations necessary to design field studies.

MARTYN JEGGO

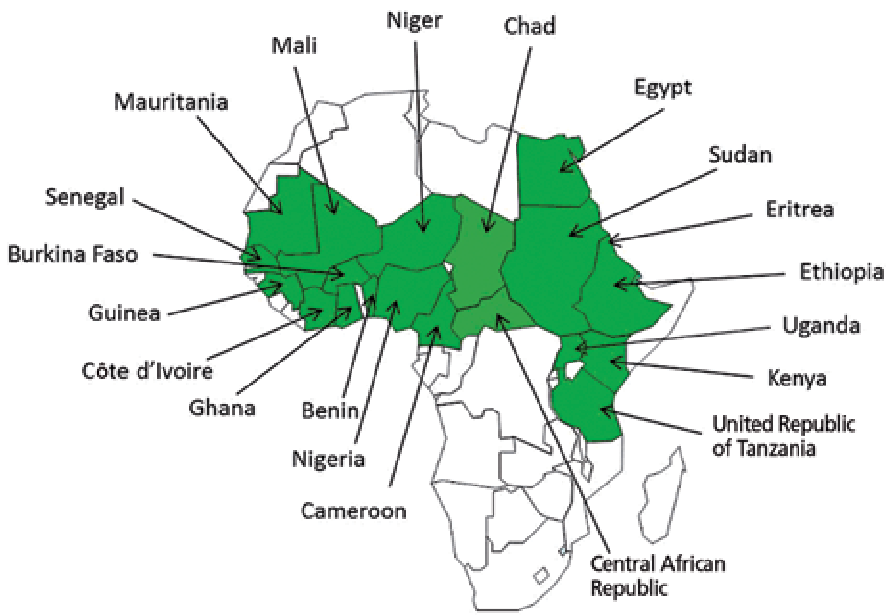
Joint FAO/IAEA Division–OAU-IBAR training course on rinderpest ELISA, Entebbe, Uganda, 1992

Alongside this diagnostic platform, one of the most successful advances in the multi-country eradication effort was the establishment of a laboratory network in Africa (Figure 1) in 1988, which continues today. The objectives of this network were to:

- improve diagnostic capacity at regional and national rinderpest laboratories;
- promote consistency and rigour in methodology;
- support coordination and harmonization of regional approaches for early warning, efficient detection and early response during rinderpest surveillance;
- enhance regional capacity and cross-border collaboration to enable more effective responses to other transboundary animal diseases;
- build trust for enhanced transparency and mutual confidence in disease information;
- facilitate a dynamic approach for interaction among countries and enhanced information sharing among national veterinary laboratories in the region;
- identify weaknesses in procedures and techniques in time to allow adequate improvements.

The network was also an ideal forum for the Joint FAO/IAEA Division and the IAEA Technical Cooperation Department to introduce and apply a quality assurance system for the international acceptance of test results. As the objective of the rinderpest campaign was to eradicate the disease, it was clear that vaccination campaigns to reduce disease incidence should be followed by disease surveillance to detect and eliminate any residual foci of rinderpest virus infection. To accomplish this, all countries required guidelines on how to obtain recognition of freedom from rinderpest. These guidelines were established at an expert meeting in 1989 at OIE. They defined three stages, and became known as the OIE Pathway, with declaration of: i) provisional freedom from disease; ii) freedom from disease; and iii) freedom from infection. The

Figure 1: Rinderpest surveillance network



OIE Pathway set up general criteria and conditions for verifying that a country had reached each stage. To help countries fulfil these criteria and proceed through the three stages, the Joint FAO/IAEA Division – through IAEA and FAO technical cooperation mechanisms and with the help of experts – designed quality assurance and performance indicators, which they introduced to collaborating laboratories, enabling counterparts to perform effective disease surveillance and obtain reliable test results for confirming disease control and, eventually, ensuring elimination.

In parallel with the campaign in Africa, countries in the Near East and Southeast Asia were also stepping up their rinderpest control measures.

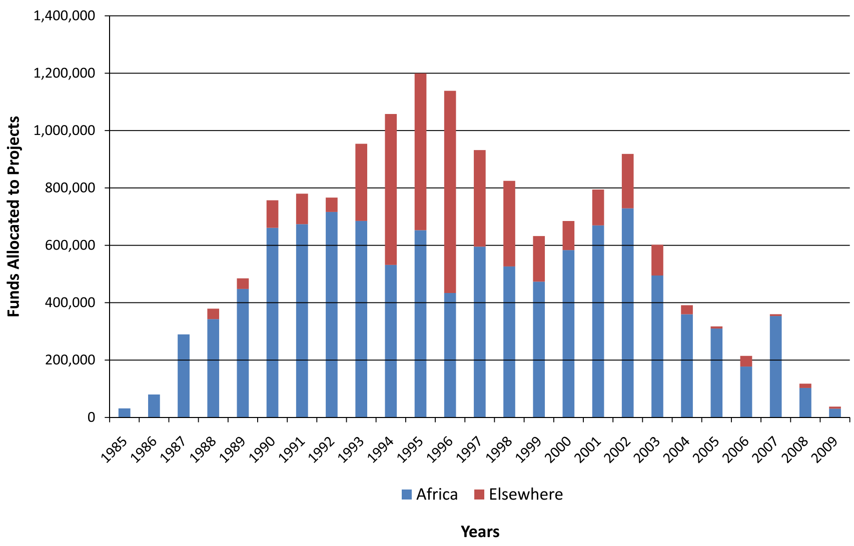
The tools developed for PARC were used by WAREC, SAREC and eventually all GREP member countries, and their application was demonstrated at training courses to initiate adoption of the OIE Pathway.

A total of 14 member countries, from Turkey to Mongolia, participated in regional meetings and initiated surveillance activities, supported by expert missions organized by the Joint FAO/IAEA Division.

In its contribution to GREP, the Joint FAO/IAEA Division adapted all of its activities to the needs of FAO and IAEA member countries, from the standardization, validation and distribution of diagnostic kits, to the specific equipment and software development for data analysis. Overall, the activities of the Joint FAO/IAEA Division and the IAEA Technical Cooperation Department during GREP aimed to build capacities in partner countries' veterinary diagnostic laboratories to enable them to:

- analyse sera for vaccination sero-monitoring;

Figure 2: Yearly breakdown of the Joint FAO/IAEA Division and IAEA Technical Cooperation funds contribution to GREP



- analyse samples (tissue and sera) as part of disease investigation and in compliance with the OIE Pathway;
- investigate suspected outbreaks in an open, transparent and documented fashion (including the laboratory component);
- apply routine performance indicators for test validation;
- carry out other animal disease surveillance and control efforts.

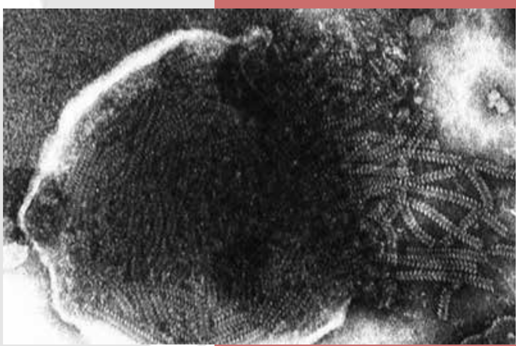
In total, the IAEA programme contributed approximately USD 20 million (Figure 2) to rinderpest eradication. These funds came through IAEA's coordinated research projects and technical cooperation projects, with financial and technical support from other organizations including the Swedish International Development Cooperation Agency (Sida), FAO, OIE, the European Commission/EU, IAH in the United Kingdom, and CIRAD in France.

Contributors: Hermann Unger, Adama Diallo and Gerrit J. Viljoen
(Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture)

The Institute for Animal Health's contribution to the eradication of rinderpest

IAH's contribution to rinderpest eradication was in three main and closely linked areas: the advancement of knowledge about the virus; the development of new diagnostic techniques; and the implementation of training and monitoring systems to improve national and international control programmes. In the later stages of the campaign, when it was formalized as GREP, IAH acted as FAO's World Reference Laboratory (WRL) for rinderpest,[5] providing diagnostic services, training and advice to many countries, and information to OIE and FAO to assist the coordination of international activities.

IAH's work on rinderpest began in earnest about 1980 with the arrival of William Taylor. During this period, IAH contributed as both a rinderpest vaccine manufacturer and a resource for vaccine training skills. In collaboration with FAO, quality assurance tests were conducted on vaccines obtained from African manufacturers. Concern about the variable results of these tests provided the impetus for developing FAO's PANVAC. Another vital contribution at this time was the gathering of rinderpest virus (RPV) strains and demonstration of the varying virulence of different isolates in sets of cattle belonging to the same breed.


KAUSHIK AND SHAILA

Rinderpest virus

Another very important contribution was development of the rinderpest ELISAs used throughout GREP for sero-monitoring and sero-surveillance (first with the indirect ELISA and then with the monoclonal antibody-based competitive ELISA). This work was carried out by John Anderson and colleagues in the 1980s, and allowed virus neutralization tests – which were time-consuming, difficult to standardize and technically demanding – to be replaced by much simpler and more robust ELISA test kits. The first ELISA was field tested and validated during work in the United Republic of Tanzania, led by Anderson and funded by the EU. Anderson then went on to collaborate with the IAEA/FAO Joint Division on establishing the rinderpest laboratory network, which played an important part in PARC. IAH ran training courses and annual coordination meetings for the network, and provided trouble-shooting support for national and regional laboratories in implementing the ELISAs, which became essential tools for sero-monitoring and later sero-surveillance. Anderson and others at IAH continued this training and trouble-shooting role as rinderpest control programmes extended into the Middle East and Asia. In 1990, he developed the competitive ELISA as a more specific and sensitive test that can be applied across many host species, including wildlife.

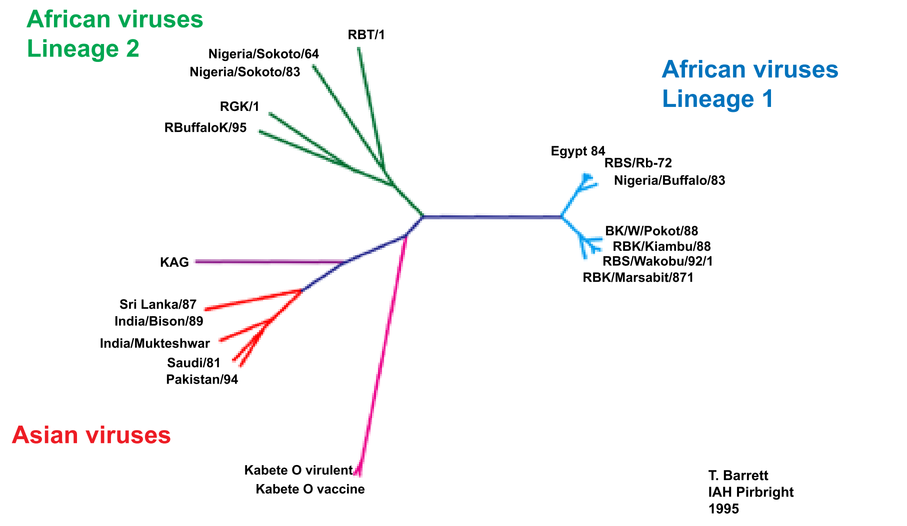
[5] www.iah.ac.uk/disease/rinderpest.shtml.

Throughout the eradication programme, IAH manufactured and supplied ELISA kits, working closely with local users to ensure that the kits functioned and were reliable, even under difficult local conditions. Based on its development of these tests, its work to support and develop the rinderpest network and its experience of rinderpest control, IAH became the FAO WRL for rinderpest in the early 1990s. Anderson and Anke Bruning also developed a rapid pen-side test for diagnosis of rinderpest in the field, which was based on lateral flow technology and allowed diagnosis from an eye swab within ten minutes. Availability of this field test greatly assisted in identifying the remaining foci of infection in Pakistan and detecting the clinically mild rinderpest strain present in the United Republic of Tanzania.

The basic biology of RPV was studied at IAH from the late 1980s, led by Tom Barrett, who was joined later by Michael Baron. This work resulted in the complete sequencing of the virus (both virulent and vaccine strains) and the development of a system for making recombinant RPVs. The system led to the creation of numerous modified RPVs, which contributed greatly to knowledge about the virus's biology and creation of a number of differentiating infected from vaccinated animals (DIVA) or "marker" vaccine candidates. The molecular basis for the attenuation and stability of the Plowright vaccine was discovered, the virus receptor was identified, and the functions of the different viral non-structural proteins were explored.

The vaccines based on recombinant RPVs were not used in the field, but provided important information that will be of use in work to control peste des petits ruminants virus (PPRV). Recombinant pox virus-based vaccines were also created and tested, and the knowledge these provided on the nature of the protective immune response to morbillivirus infection has already helped in designing DIVA vaccines for control of PPRV.

Figure 1: Phylogenic relationships of rinderpest viruses



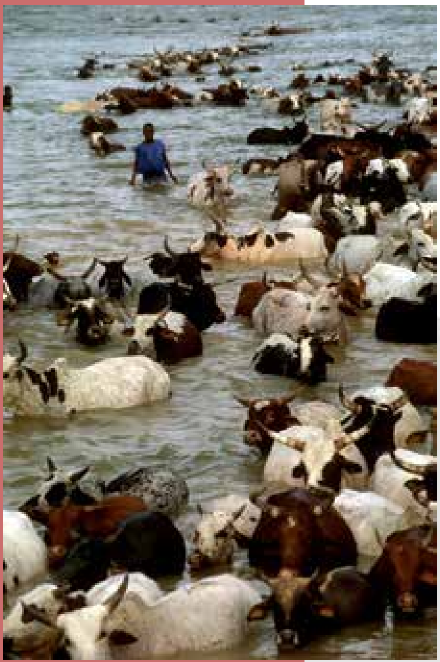
T. BARRETT (IAH PIRBRIGHT)

Knowledge of the sequence of the virus allowed Barrett to develop rinderpest-specific polymerase chain reaction (PCR) primer pairs, which provided the basis for the PCR-based diagnostic tests used in the WRL. These tests were coupled with deoxyribonucleic acid (DNA) sequencing and phylogenetic analysis of the virus isolates, which led directly to the identification of the separate African and Asian lineages of RPV. The ability to identify and track the origin of a virus isolate became increasingly important in the later stages of the eradication campaign, and was crucial in identifying the existence of low-virulence strains circulating in areas thought to be free of disease. The PCR tests were used extensively at the WRL to improve diagnostic assay throughput, replacing the need for virus isolation and characterization. They were also passed on to other regional and national reference laboratories, with support from the IAEA/FAO Joint Division.

An important factor in this work was that IAH, both before and after its establishment as the WRL for rinderpest, acted as a large, secure collection point for RPV isolates from around the world. The availability of a large number of distinct isolates in one place greatly facilitated the comparison of strains in terms of their pathogenicity under defined conditions, and enabled the development of the sequence database that underpinned the phylogenetic analysis described in previous paragraphs. Many historic samples that are no longer available in their countries of origin are still stored at IAH Pirbright. It is hoped that these isolates will eventually be completely sequenced, to preserve the historical record of the virus, now that it has been eradicated from the wild.

Contributor: Michael D. Baron (IAH, Pirbright)

The CIRAD contribution to rinderpest eradication


FAO/A. GANDOLFI

Cattle in the Niger River, Mali

Rinderpest, which was a major incentive for establishment of the first veterinary school at Lyon in 1764 and later of OIE, also motivated the implementation of an international training course in Maisons-Alfort (France) in 1921, which aimed to improve the control of rinderpest. This postgraduate teaching in exotic medicine was soon organized into an institute, *Institut de médecine vétérinaire exotique,* then, the *Institut d'Elevage et de Médecine Vétérinaire Tropicale* (IEMVT), which was created in 1948 and merged with other French agronomic institutes in 1984, to create CIRAD.[6] For simplicity, this chapter uses the name CIRAD. All the scientists mentioned work at CIRAD unless otherwise stated.

The history of CIRAD's contribution to rinderpest eradication is also the history of strong collaboration with national, regional and international veterinary services (OIE, FAO, AU-IBAR) and animal health research centres. A large and significant body of field and laboratory work was carried out during the period. A few years ago, it was still possible to meet pastoralists in remote areas of Chad or the Central African Republic who remembered seeing French vets use their goats to vaccinate cattle with the "caprinized" rinderpest vaccine.

Pan-African vaccination campaigns and the pledge for eradication

CIRAD was involved in all aspects of rinderpest research and control activities since the early 1950s. Most of this work was conducted in the national laboratories of Chad (Farcha; Provost, 1966), Senegal (Dakar) and Ethiopia (Debre Zeit; Lefèvre and Domenech, 1974), which are now important components of their respective national animal disease control and research systems. Dakar and Debre Zeit laboratories are major international stakeholders in disease control, through the networks and reference centres of the West and Central Africa Veterinary Laboratory Network for Avian Influenza and other Transboundary Disease (RESOLAB, coordinated by FAO, OIE and AU-IBAR) and PANVAC (coordinated by AU-IBAR).

Starting in the 1950s, CIRAD teams worked throughout large areas of Africa, disseminating use of the caprinized rinderpest vaccine developed in India by Edwards (IVRI, Mukteshwar) in 1920. In the early 1950s, Plowright (IBED, Muguga, Kenya) attenuated a strain of rinderpest virus by serial passages of a wild virus on cell culture (Plowright and Ferris, 1959). From 1953, CIRAD engaged in the production and dissemination of this new vaccine (Mornet, Gilbert and Mahou, 1957).

[6] www.cirad.fr/en/research-operations/research-units/emerging-and-exotic-animal-disease-control.

Following the reoccurrence of rinderpest in western and eastern Africa in the late 1970s, after the conclusion of JP15, an emergency West African campaign was launched in 1981, managed by Yves Cheneau and funded by EDF. At the same time, Alain Provost advocated for the funding and implementation of a pan-African rinderpest vaccination campaign. With the support of Louis Blajan, Director-General of OIE, he was able to convince Jan Mulder, head of EFD in Brussels, to support this idea, which was also accepted by the African nations. During an OIE/FAO/OAU-IBAR joint meeting in Paris in February 1982, Alain Provost drew a parallel between rinderpest and smallpox, and expressed the idea that rinderpest eradication was achievable with the scientific knowledge and technical expertise that was available (OIE, 1982).

CIRAD's scientific involvement in rinderpest eradication

CIRAD scientists have published more than 500 scientific articles, communications and notes on rinderpest, from Curasson in 1932 to today (the number rises to 750 if articles on peste des petits ruminants are included). In collaboration with African colleagues, veterinary schools, the Pasteur Institute and IAH Pirbright Laboratory (United Kingdom), these scientists have contributed to the scientific foundations for success of PARC and PACE, and to the OIE Pathway for rinderpest eradication. For instance, CIRAD contributed to the finding that wildlife was a victim of, but not a reservoir for, rinderpest virus, and that wild animal populations could be used to monitor and certify the disappearance of rinderpest from the African continent (Couacy-Hymann *et al.*, 2005; Kock *et al.* 2006). CIRAD scientists also suggested that peste des petits ruminants was helping prevent the dissemination of rinderpest. Important advances were made on improved thermo-stability of vaccines and new recombinant vaccines, and on the development of diagnostic tests for virus or antibody identification. Rinderpest and peste des petits ruminants viruses are the only representatives of the *Morbillivirus* genus whose host ranges overlap, and are strikingly similar in terms of the clinical signs they induce. Thus, to be fully effective in determining the causative agent in an outbreak, particularly in small ruminants, laboratory tests had to be sensitive and specific and provide quick results to confirm clinical suspicions. The combination of modern immunology and molecular biology techniques allowed CIRAD to develop diagnostic tests in a kit format (Diallo *et al.,* 1995; Libeau *et al.*, 1995), which was routinely used by the national veterinary laboratories involved in PARC and PACE.

Innovative concepts and methods have always been central to the work of IEMVT and CIRAD, and collaboration with African partners led to a knowledge-based control of rinderpest. This collaborative work illustrates how science-based control programmes, coordinated at the regional and global levels and appropriately funded by international donor support, can be successful and generate high economic returns. Rinderpest eradication should be considered an example for the control of other major animal and zoonotic disease agents with major impacts on food security and public health.

Contributors: Geneviève Libeau, Renaud Lancelot and Dominique Martinez
(Biological Systems Department, CIRAD)

Contribution to the eradication of rinderpest in Somalia: the experience of Terra Nuova[7]

A mild form of rinderpest was described and diagnosed in Tsavo East National Park in Kenya in 1994, and subsequently in Nairobi National Park (in 1994 to 1996). Initially the Tsavo rinderpest outbreak was thought to have originated from southern Sudan, but molecular evidence clearly showed that the Tsavo virus was genetically very different from the isolates from Nairobi National Park and fell into the African type 2 lineage. The exact location of this focus was uncertain, but it was suspected that the virus could have remained undetected for several years in the Northeast Province of Kenya and the neighbouring Trans Juba Region of southern Somalia.

When the Siad Barre regime collapsed in 1991, all public institutions, services and assets were seriously disrupted or looted. This was followed by massive displacement of people inside and outside Somalia, widespread insecurity, serious famine, and the collapse of most formal economic activities. To alleviate the consequences of the humanitarian crisis and the collapse of the Somali state, the international community launched a significant response, with peacekeeping operations, direct assistance to displaced populations, restoration of local administrations, rehabilitation of public infrastructures, and support to economic activities. Given its socio-economic importance and prominence, the livestock industry was one of the sectors targeted for relief and rehabilitation interventions, through mass vaccination campaigns against infectious diseases, curative treatments, rehabilitation of watering facilities, and training of veterinary professionals and para-veterinarians. During this period, rinderpest was one of the target diseases, especially in light of global efforts to eradicate the disease from the African continent, and particularly from Somalia, which was one of the last suspected foci of infection.

Terra Nuova,[8] one of 12 international non-governmental organizations (NGOs) initially involved in the livestock programme, was entrusted with providing technical advice, especially through training support to Somali veterinary professionals, and later through implementing field activities in the Somali regions of Gedo, Lower and Middle Juba bordering Kenya. These three regions were suspected of hosting the remaining foci of rinderpest in Somalia.

Owing to the mild clinical presentation of the disease, the nomadic nature of the Somali cattle herds, the vast area to be covered, the prevailing instability and insecurity in the country, and the lack of basic infrastructure and qualified human resources, the eradication of rinderpest presented several challenges. Terra Nuova's involvement in rinderpest eradication activities in Somalia was characterized by interventions along six main thrusts: i) the delimitation of rinderpest-infected areas through active disease search, serological surveillance in cattle and other susceptible wild species, risk mapping, participatory disease search (PDS), participatory epidemiology and historical information gathering;

[7] This chapter is dedicated to the memory of Manmohan Bogal, who was killed while supervising a rinderpest vaccination campaign in Gedo Region, Somalia, on 26 January 1999.

[8] www.terranuova.org/.

ii) vaccination campaigns for the cattle population at risk; iii) capacity building of Somali veterinary professionals and their associations, local administrations and, later, national veterinary authorities; iv) coordination with global (GREP), continental (PARC and PACE) and regional (SERECU) programmes and approaches; v) partnerships with international (FAO and the International Livestock Research Institute [ILRI]), continental (AU-IBAR) and non-governmental organizations (Cooperazione Internationale [COOPI], *Vétérinaires San Frontières Suisse* [VSF-CH], UNA and VSF Germany) ; and vi) prompt dissemination of the data collected through reports, publications and presentations at technical fora. All the data gathered in the course of the years of intervention (1996 to 2009) contributed to the dossier prepared by the Somali Veterinary Authority for the recognition of Somalia as officially free from rinderpest, which OIE granted in 2010.

Structured serological surveys were conducted between September 2002 and November 2007, based on two-stage cluster sampling and using random map coordinates to identify sampling locations. This resulted in the sampling of 1 608 sites, mostly in Central and South Somalia,[9] and the collection of 28 700 serum samples, most of them from cattle and only 97 from warthogs. During PDS related activities, 1 425 specimens were collected for virus isolation and serological tests. All serological surveys and PDS activities were carried out by Somali veterinary professionals who had been specifically trained and equipped. More than 1 300 questionnaires were administered to pastoralists, to gather historical and recent data on rinderpest occurrence and other information on cattle population dynamics.

Vaccination campaigns, using thermo-stable rinderpest vaccine produced by the Botswana Vaccine Institute, were conducted in southern Somalia by Somali veterinary teams who had been specifically trained, equipped and contracted. The capacity building component was particularly demanding, but also crucial for the success of the intervention, especially at the beginning, when Somali veterinary authorities were either absent or very weak. Major concerns regarded the legitimacy of interventions, the representation of Somali interests in international and continental arenas, and the use of epidemiological information. Memoranda of Understanding were drawn up to address these concerns, initially with local authorities and later with the Somali Veterinary Authority.

TERRA NUOVA

Manmohan Bogal

The development and implementation of varied investigation techniques, including the use of random sampling methodologies adapted for highly mobile animal populations and the establishment of a country-wide network of trained Somali veterinary professionals collaborating with the central authorities, made it possible to obtain official accreditation of freedom from rinderpest in 2010.

Terra Nuova expresses its gratitude for the support and contributions of the EU, international, regional and local organizations and the veterinary professionals of Somalia, which led to the final eradication of rinderpest from the country.

Contributor: Terra Nuova

[9] Only 61 sites were sampled in cattle rearing areas of Puntland and Somaliland.

The eradication of rinderpest from southern Sudan

In 1994, *Vétérinaires Sans Frontières* (VSF) Belgium was one of the NGOs that joined the Operation Lifeline Sudan (OLS) Livestock Programme coordinated by the United Nations Children's Fund (UNICEF) in conflict-affected southern Sudan. The objective of the programme was to improve household food security through the control of rinderpest and the establishment of community-based animal health services. VSF Belgium trained and supported community-based animal health workers (CAHWs) in several agropastoralist communities of southern Sudan. The CAHWs carried out rinderpest vaccination using heat-stable vaccine, and provided vaccinations and treatments for other important diseases of cattle, sheep, goats and poultry. In 1996, VSF Belgium set up a training centre for mid-level animal health workers, to provide a cadre of animal health auxiliaries (AHAs) as CAHW supervisors and field coordinators.

FAO/VAN DER STAPPEN

Cows returning to a cattle camp at sunset

As a result of the widespread vaccination efforts, rinderpest outbreaks decreased and apparently stopped. The last confirmed rinderpest outbreak was in 1998, although there was a suspected but unconfirmed outbreak in 2001. About this time, FAO-GREP advised the Republic of Sudan to stop vaccinating and to enter the surveillance phase of the OIE Pathway to freedom from rinderpest.

In 2001, VSF Belgium was contracted by OAU-IBAR's PACE to implement the rinderpest eradication project for southern Sudan. Within the framework of the OLS Livestock Programme (now led by FAO Southern Sudan), VSF Belgium managed and coordinated the cessation of rinderpest vaccination and the establishment of a rinderpest surveillance system. The eradication project was carried out in close coordination with the Government of the Republic of Sudan's PACE Sudan Project, which covered northern Sudan, and was implemented in partnership with the new Ministry of Animal Resources and Fisheries of the Government of Southern Sudan, following the advent of peace in 2005. Technical advice was provided by PACE and GREP.

In preparation for the cessation of vaccination and the intensification of surveillance, appropriate communication methods and materials were developed to raise the awareness and understanding of all major stakeholders, especially livestock keepers and their communities. Rinderpest vaccination was popular, so it was necessary to explain why it was ending and the importance of reporting quickly any disease outbreak that might be rinderpest. Training courses were developed for CAHWs, AHAs and field veterinarians, so that they could play their roles in raising livestock keepers' awareness and rinderpest surveillance.

The last rinderpest vaccinations were carried out in June 2002, and all vaccine was removed from southern Sudan. Contingency plans and supplies were put in place for rapid response in case of a subsequent rinderpest outbreak.

The last rinderpest vaccinations were carried out in June 2002

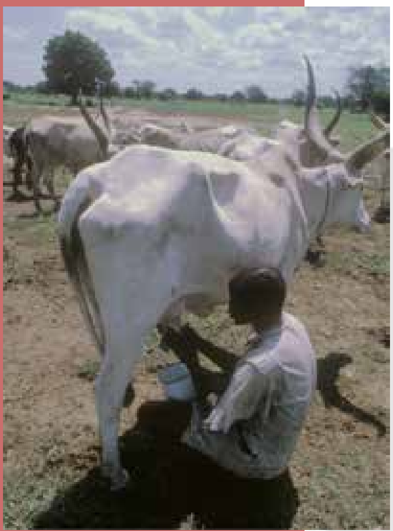
The disease outbreak reporting system was strengthened to ensure that any rinderpest outbreak that occurred would be rapidly detected and controlled, and, if rinderpest was no longer present, to provide evidence of freedom from infection. All stakeholders were encouraged to report any outbreak that could be rinderpest, and these reports were fully investigated. In spite of the USD 500 reward offered for a confirmed rinderpest outbreak, all outbreaks were shown to be caused by other diseases, and no rinderpest was confirmed. Several methods of active surveillance were introduced. AHAs carried out regular visits to cattle camps and markets to interview livestock keepers and traders about disease problems and to carry out clinical examinations of cattle. Teams of animal health workers led by veterinarians carried out participatory disease searches in areas perceived to be at high risk of rinderpest: livestock keepers were interviewed about current and recent disease problems in their areas, and their cattle were examined. Blood samples were collected from various wildlife species, to check for evidence of rinderpest infection. Two annual random sample serological surveys were carried out to meet the OIE requirements for verifying absence of rinderpest infection: in each survey, state teams of animal health workers led by VSF Belgium or state veterinarians collected more than 8 000 sera from more than 300 herds, and only four head of cattle from different areas were found to be antibody-positive in each survey. Follow-up investigations of these eight cattle found no evidence of rinderpest disease or infection.

The surveillance data were compiled and became part of the Republic of Sudan's application to OIE for recognition of freedom from rinderpest disease and, ultimately, freedom from rinderpest infection, which OIE recognized in 2008. The elimination of rinderpest from southern Sudan was achieved in a very difficult security situation, in challenging environmental conditions and with limited personnel and resources. This was possible because of the availability of heat-stable rinderpest vaccine; strong communication with livestock keeping communities; the training of a network of CAHWs and AHAs to carry out vaccination and become the frontline of the surveillance system; and the coordination and participation of NGOs, local authorities, government and United Nations organizations.

Contributor: Bryony Jones (former VSF Belgium Rinderpest Eradication Project Manager)

Vétérinaires Sans Frontières Suisse activities to eradicate rinderpest from southern Sudan

As part of a joint programme with a dozen other NGOs working in southern Sudan under the global umbrella of the United Nations OLS, in 1995, VSF Suisse (VSF-CH)[10] started to collaborate with FAO on the eradication of rinderpest in this part of Africa.



FAO/VAN DER STAPPEN

Woman of an ethnic group in Thiet milking a cow

VSF-CH has been working in eastern Africa since 1995. Its overall objective in southern Sudan was to improve household food security and quality of life for 71 000 households in Northern Bahr El Ghazal Region and 63 000 in Western Upper Nile Region, by improving livestock productivity.

The first specific objective was to improve livestock health and productivity by supporting a viable community-based animal health service. The second was to contribute to the eradication of rinderpest by 2010, following the recommendations of GREP, OIE and PACE. Activities were carried out through ten VSF-CH base stations covering 14 *payams* in Aweil East and Twic Counties of Northern Bahr el Ghazal, and 18 *payams* in Leer and Koch Counties of southern Western Upper Nile. The beneficiaries were Nuer and Dinka pastoral communities, who were suffering from the longstanding war that hampered daily life in southern Sudan for 20 years until a peace agreement was signed in January 2005.

The main task was to provide technical support for the delivery of animal health services: rinderpest vaccination, until it was replaced by surveillance in January 2002; surveillance for other transboundary animal diseases; drug and vaccine distribution; treatments and vaccinations; and capacity building.

The first aim was to control livestock diseases with a significant impact on reducing milk yields, as milk is the major marketable or consumable product from livestock raising. Benefits that households gain from healthy animals include milk; and animals for use as dowries in Dinka marriages, for herd replacement, as exchange for grain in times of hunger, or for sale to raise capital to purchase heifers to increase herd sizes.

For the second objective (eliminating rinderpest), any suspected outbreaks or rumours of rinderpest were investigated immediately by local counterparts and field veterinarians. If needed, teams of rinderpest-specialized veterinarians were then sent by FAO-GREP. In 2002, there was no rinderpest outbreak in any location where VSF-CH was active. In June 2002, rinderpest vaccination ceased throughout the Sudan (north and south), including in all VSF-CH locations (in January 2002). This was in accordance with the PACE Southern Sudan strategy, to allow active surveillance of each rinderpest "look-alike" disease and close examination of any antibodies against the wild virus strain (if present), without running the risk of confusion with antibodies produced by the vaccine strain.

[10] www.vsf-suisse.ch/.

To facilitate local surveillance, CAHWs were trained to recognize rinderpest symptoms, and a reporting system was put in place for use in any rinderpest outbreak. A reward system was established for stakeholders participating in the chain process of recognition, reporting and confirmation.

Vaccination against rinderpest decreased in parallel with the reduction of risk as perceived by livestock owners. Between January and September 2000, there were 162 592 vaccinations against rinderpest. In 2001, total rinderpest vaccinations reached 53 968.

In 2002, the number of bacterial vaccinations, for example against contagious bovine pleuropneumonia, haemorrhagic septicaemia, anthrax and black quarter (218 734), was 1.8 times higher than that of all vaccinations, including against rinderpest, in 2001 (at 174 631, or 53 968 for rinderpest and 120 663 for other diseases). FAO provided vaccines, and VSF-CH donors supported maintenance of the cold chain for transporting vaccines to herds.

There were two main reasons for the increase in vaccination against bacterial diseases. First, VSF-CH had conducted important sensitization campaigns with communities, breeders and CAHWs informing them about the massive vaccination campaigns it planned to carry out during the dry season, to avoid having to rely on urgent ring vaccinations to constrain spread after a disease outbreak. This represented a truly preventive vaccination campaign, aimed at a larger number of animals than post-infection vaccinations over a geographically limited area. Such a preventive strategy proved to be fruitful, as fewer disease outbreaks were reported – at this stage, livestock owners were more concerned about diseases other than rinderpest. Surveillance for rinderpest was assisted by a broad preventive approach, using vaccinations against bacterial diseases that were of immediate concern to livestock producers.

Vaccination against rinderpest decreased in parallel with the reduction of risk as perceived by livestock owners

Second, VSF-CH was committed to respecting the drug pricing policy developed from the livestock coordination meeting held with FAO and the other NGOs involved in the programme. This policy aimed to prepare the shift from an emergency phase (lasting 20 years) when drugs were provided free, to a rehabilitation phase, when the real costs of drugs, including business margins, would be passed on to communities (although transport costs would continue to be subsidized). This was in preparation for the privatization of sustainable veterinary services. To implement this approach, VSF-CH introduced a new monthly summary form, allowing the regular follow-up of each CAHW's performance in terms of, for example, the number of treatments carried out compared with the quantity of drugs delivered, and the amount of cost recovery achieved compared with what was expected. This developed a responsible attitude among service providers, as it linked each treatment to a systematic clinical approach aimed at ensuring proper clinical diagnosis. This change of mentality found a significant echo among breeders, who were ready to pay for quality animal health services. Thanks to strict application of the price rules, VSF-CH locations were the first in which private or community veterinary pharmacies were ready to obtain and market products from the north, even before the peace in 2005. As massive vaccination was more cost-efficient than massive treatment, it was predictable that breeders would prioritize vaccination rather than treatment, which appeared costly and was often inefficient for viral diseases.

Strict application of the cost recovery system helped decrease the total number of treatments. A strict payment for services policy generated a trend for moving from costly curative treatments to cheaper preventive vaccinations. A division of the total cost by the number of treatments and vaccinations provided in 2002 gave a value of EUR 4.7 per treatment or vaccination (EUR 1 315 900 for 277 973 treatments), representing a move towards relatively affordable and sustainable overheads for producers.

The success of rinderpest eradication and surveillance was also due to proper capacity building. By the end of 2002, 206 CAHWs (150 male and 56 female) were being supervised by 30 AHAs and five veterinarians, of whom two are now the Chief Veterinary Officer and Deputy Chief Veterinary Officer for Southern Sudan. VSF-CH and *Pharmaciens Sans Frontières*[11] elaborated and distributed an illustrated handbook to assist CAHWs in their animal health role.

The livestock producers gained the following important benefits from this integrated animal health programme:

- reduced mortality, due to treatments and vaccinations specifically against rinderpest, which resulted in increased numbers of animals;
- reduced morbidity and sickness of livestock, which resulted in increased milk yields.

Contributor: Nicolas Denormandie (Former VHF-CH Programme Coordinator for South Sudan, 2000 to 2003)

[11] www.psfci.org/.

Rinderpest: a personal perspective

I started my career with FAO in 1971 as an associate expert working on a UNDP/FAO Beef Industry Development Project in Kenya. After three years, I became a full expert, and continued for a further two years until 1976, when I was recruited by the European Commission. My programme responsibilities then included assisting the development and implementation of animal production projects that were partly financed by the EU.

At this stage, I had heard of rinderpest, and JP15 was frequently mentioned in the context of programme discussions. This project was one of the first large-scale projects in Africa to be co-financed by EDF, and it had been very successful. Rinderpest had been brought under control and was reputed to have been eradicated from Africa. Indeed, I remember from my time in Kenya that special commemorative stamps had been issued to underline this achievement.


PETER. L. ROEDER

Cattle herd

However, in the early 1980s, a delegation from IBAR appeared in my office with bad news. There were serious indications that the dreaded disease had reappeared in the United Republic of Tanzania and Nigeria. It was likely that rinderpest would raise its ugly head again in several parts of Africa. The matter at hand was would it be possible for the EU to finance another JP15?

For several months, discussion raged in the services of the Development Directorate of the European Commission as to what the response should be. That the EU should help was not in question, but rather what approach should be followed? Two schools of thought developed. One school said that in view of the seriousness of the disease unconditional aid should be provided, and fleets of transport and vaccination equipment with related supplies should be sent to Africa. In addition, the new campaign should not overlook any animal, as had apparently been the case in the earlier large-scale campaign. The other school argued that it was peculiar that the disease could have spread so quickly after its reappearance. It was clear that some 15 to 20 years after independence most African countries had built up an abundance of qualified veterinarians and related personnel, but most of these veterinary personnel were underemployed. After finishing their studies, almost all veterinarians were automatically recruited by their governments, but the governments were not providing the necessary funds for the veterinary personnel to do their work. The real challenge was not only to combat rinderpest but to use the enormous pool of veterinary personnel more effectively. The challenge in this approach was to revitalize the veterinary services in Africa by providing them with a stable source of financing. To my great satisfaction, the latter school of thought prevailed.

IBAR also proved to be receptive, under its new director Walter Masiga. The new strategy was developed in close cooperation with the World Bank. Countries that were in immediate danger were assisted with emergency aid. At the same time, funds were set aside to develop a thermo-stable vaccine so that the costly cold chain would not be necessary anymore.

A dialogue involving all the countries was started on how to achieve better financing of veterinary services. A number of options had been identified in a financing agreement with the then OAU-IBAR. A first item for discussion in several countries was the issue as to whether vaccinations should be free of charge or not. This was also a controversial issue in the EU itself. In certain countries of the EU, compulsory vaccinations against foot-and-mouth disease were without cost to the farmer, while in others farmers had to pay the full costs of vaccination. The prevailing view in Africa was that all compulsory vaccination campaigns had to be free of charge. This was not a concern for the EU, but it was clear that the costs of these campaigns could not be borne indefinitely by donors. It was suggested that if governments were unable to fund the campaigns, one alternative was to ask for a contribution from farmers.

After all, it was argued, the cost of a vaccination was minimal compared with the value of the animal. Other options were also put forward; for example, via a system of levies on animal products, cooperatives and farmers' associations could provide certain veterinary services free of charge. The same farmers' organizations could also be encouraged to recruit their own veterinary personnel to serve their members. One option proved to be very controversial. In several African countries, imports of animal products were often detrimental to local farmers, so would it be possible to impose an import levy, and use this for financing the vaccination campaigns? The International Monetary Fund was not amused by this suggestion, as all taxation had to go to the central government budget. The final option suggested was to privatize the existing public sector veterinary services. In many countries in Africa, all veterinary services were provided by the public sector, and this seemed an unsatisfactory situation. It was agreed that the EU would assist the development of the necessary policy frameworks for privatizing veterinary services.

AKIKO KAMATA

Cattle resting in the shade

In this regard, the EU was firmly of the opinion that no option should be imposed on any country, and that each situation had its own solution, which might vary from country to country, and even from region to region within a country.

In 1994, I became a member of the European Parliament. From time to time I met old acquaintances and was told about the unfolding of the struggle against rinderpest. This culminated in the announcement earlier this year that rinderpest had been eradicated. It has to be fervently hoped that this declaration can stand the test of time.

All those involved are to be congratulated. FAO has been very active as a mediator, but special praise should be reserved for the vaccination teams that have roved around in difficult conditions in Africa. I have always been impressed by the diligence of the people who work at the grassroots level.

I know from my experience in the European Parliament that it is not easy to change ingrained policies. I am therefore not too sure how far Africa has changed its policies for the funding of veterinary services. However, I remain optimistic that one day Africa will stand on its own feet and be able to develop its animal production resources without any donor funding.

Contributor: Jan Mulder (Member of the European Parliament)

The costs and benefits of rinderpest eradication

In addition to health risk, animal diseases inflict a broad spectrum of direct and indirect economic costs on society, many of which are neither well-understood nor rigorously analysed. Various methods exist to evaluate economic impacts, but many of these focus only on specific aspects or stakeholder interests and how they are affected by a disease, and do not capture the totality of impacts across the economy. However, these economy-wide considerations are essential to comprehensive *ex-post* evaluation of disease control or eradication programmes. Direct disease incidence and control costs may be focused on particular stakeholder groupings, but spill-over costs and benefits are dispersed more widely, traversing agricultural supply chains and associated households and enterprises. These extensive indirect effects often outweigh the direct ones. For this reason, cost-benefit analysis of animal disease and policy response must include a broad spectrum of both direct and indirect impacts in the assessment.

Cost-benefit analysis of animal disease and policy response must include a broad spectrum of both direct and indirect impacts in the assessment

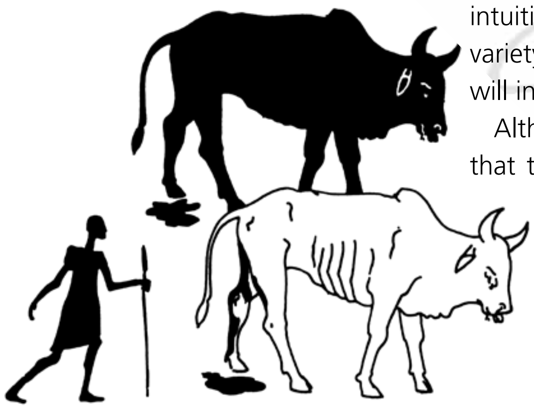
Rinderpest was once one of the world's most feared livestock diseases, but concerted international control campaigns have now eradicated the disease globally. Despite this success, a major gap remains in the history of rinderpest eradication, namely a comprehensive assessment of the socio-economic costs and benefits of its control and eventual eradication. Such an assessment would make an important additional contribution, offering policy-makers an instrument for assessing the risk, cost and reward of enhanced investment in the control of other (present and future) animal diseases. Although it may be desirable to eradicate any health threat, cost-effectiveness is an important consideration, especially in developing countries, where public resources have many high priorities, and sustained expenditures require clearly discernable benefits for large segments of society. While much has been documented on the epidemiological, technical and institutional lessons resulting from rinderpest eradication, little has been written on the socio-economic impacts – what eradication means for society at the local, national, regional and global levels. What exists at present are fragmented national and international analyses, utilizing disparate and sometimes arbitrary methodologies, and not attempting to get at the "big picture" or to deliver general conclusions for guiding policy in diverse circumstances. What is lacking is a unifying framework that can bridge and synthesize the lessons from the past of rinderpest eradication and effectively inform future campaigns designed to control and eradicate other animal diseases.

To address this gap, FAO and partners are developing a more rigorous and comprehensive methodological approach to evaluate the global impact of rinderpest eradication. An important element lies in highlighting the different levels of costs and benefits associated with different stakeholder groups. Disease impacts take place at six levels of aggregation: i) household- or farm-level impacts, which can include impacts on non-farm-related livelihoods; ii) cattle sector impacts; iii) general livestock sector impacts, including substitution effects at the production and consumption levels; iv) national-level value chain impacts based on the forward and backward linkages of livestock with other sectors of the economy; v) indirect impacts at the national level, based on local externalities such as effects on the environment, wildlife and human well-being, including health, educational and employment development and other socio-economic conditions; and vi) indirect impacts at the global or subregional level, based on externality effects, such as the savings other countries receive because they no longer have to worry about disease incursion. In all of these, the cost of a disease is the sum of reduced economic activity/returns and control expenditures. While the latter can be valued directly in terms of the cash costs associated with the control of disease, the costs related to the former can also result from adaptive behaviour, such as keeping an excess of old female cattle as a risk mitigation strategy.

So far, for the purpose of developing the approach, it has been applied at a national level to estimate the impact of rinderpest eradication for Chad, by assessing the impacts on producers, sectors, and national and regional economies (within West Africa) and combining a variety of standard economic tools. This analysis suggests that there are large benefits to rinderpest eradication in Chad. At the sector level, by extrapolating the benefits associated with rinderpest control through its effects on herd demographics, the benefit-cost ratio for the totality of control programmes (JP15, PARC and PACE) over the period 1963 to 2002 is estimated at 16:45. These benefits exclude the macroeconomic and regional ones attributed to the programme. Analyses utilizing social accounting matrices (SAMs) and computable general equilibrium models yield additional insights. For instance, in 2000 (the latest year for which a complete SAM has been estimated for Chad), SAM multiplier analysis reveals that Chad's gross domestic product would have been more than 3 percent lower in a "no-eradication" scenario.

Household-level impacts from the SAM reveal that rural households, the group that was most vulnerable to outbreaks of rinderpest, would have had incomes 8.5 percent lower in the absence of rinderpest control. Breaking down these results further, it is found that shocks to livestock production have knock-on effects on rural households, through impacts on marketing and processing activities, suggesting that producers have more complex interactions within the value chain than simple intuition might suggest. This finding confirms that these households diversify into a variety of activities within the chain, so the total benefits of rinderpest eradication will include a multiplicity of non-livestock-related benefits as well.

Although these analyses must be considered preliminary, there can be little doubt that the benefits of rinderpest eradication far outweighed the costs and, from a socio-economic point of view, few investments would have yielded higher returns, particularly in countries with rural poor majorities.



Contributors: Karl Rich (Norwegian Institute of International Affairs – NUPI), David Roland-Holst (Berkeley Institute of the Environment, University of California, Berkeley, United States of America) and Joachim Otte (FAO)

Acronyms

ADB	Asian Development Bank
AHA	animal health auxiliary
APHCA	Animal Production and Health Commission for Asia and the Pacific (initially Animal Production and Health Commission for Asia, the Far East and the Southwest Pacific. The designation "Asia, the Far East and the Southwest Pacific" was replaced by "Asia and the Pacific" in 1986)
AU	African Union
AUC	African Union Commission
AWVP	African Wildlife Veterinary Project
CAHW	community animal health worker
CBPP	contagious bovine pleuropneumonia
CCTA	Commission for Technical Cooperation in Africa South of the Sahara
CIRAD	International Cooperation Centre of Agricultural Research for Development (*Centre de Coopération Internationale en Recherche Agronomique pour Development*)
COOPI	*Cooperazione Internazionale*
CTVM	Centre for Tropical Veterinary Medicine (Edinburgh, Scotland, United Kingdom)
DFID	Department for International Development
DIVA	differentiating infected from vaccinated animals
DNA	desoxyribonucleic acid
EDF	European Development Fund
ELISA	enzyme linked immunosorbent assay
EMPRES	Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases
EU	European Union
FAMA	Foundation for Mutual Assistance in Africa South of the Sahara
FAO	Food and Agriculture Organization of the United Nations
GREP	Global Rinderpest Eradication Programme
GTV	goat tissue rinderpest vaccine
IAEA	International Atomic Energy Agency
IAH	Institute for Animal Health
IAH-Pirbright	Pirbright Laboratory, IAH (United Kingdom)
IBAH	Inter-African Bureau for Animal Health
IBAR	Inter-African Bureau for Animal Resources
IBED	Inter-African Bureau of Epizootic Diseases
IEMVT	*Institut d'Elevage et de Médecine Vétérinaire Tropicale*
IIA	International Institute of Agriculture
ILMB/UC-Davis	International Laboratory for Molecular Biology, University of California, Davis campus

ILRI	International Livestock Research Institute
IVRI	Indian Veterinary Research Institute (Mukteshwar, India)
JICA	Japan International Cooperation Agency
JP15	Joint Programme 15
LCC	Landhi Cattle Colony
LCV	*Laboratoire Central Vétérinaire* (Bamako, Mali)
MINEADEP	Middle and Near East Regional Animal Production and Health Project
NA	Northern Areas
NGO	non-governmental organization
NPRE	National Project on Rinderpest Eradication
NREP	National Rinderpest Eradication Programme
NVI	National Veterinary Institute (Debre Zeit, Ethiopia)
NVSL/APHIS/VS/USDA	National Veterinary Services Laboratories, Animal and Plant Health Inspection Service, Veterinary Services, United States Department of Agriculture
NWFP	North-West Frontier Province
OAU	Organization of African Unity (now AU)
OIE	World Organisation for Animal Health
OLS	Operation Lifeline Sudan
PACE	Pan African Programme for the Control of Epizootics
PANVAC	Pan African Veterinary Vaccine Centre
PARC	Pan African Rinderpest Campaign
PCR	polymerase chain reaction
PDS	participatory disease search
PPRV	peste des petits ruminants virus
RESOLAB	West and Central Africa Veterinary Laboratory Network for Avian Influenza and other Transboundary Diseases
RPV	rinderpest virus
SAM	social accounting matrix
SAREC	South Asia Rinderpest Eradication Campaign
SERECU	Somali Ecosystem Rinderpest Eradication Coordination Unit
Sida	Swedish International Development Cooperation Agency
TCP	Technical Cooperation Programme
TCRPV	tissue culture rinderpest vaccine
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
USSR	Union of Soviet Socialist Republics
VRI	Veterinary Research Institute (Lahore, Pakistan)
VSF	*Vétérinaires Sans Frontières*
WAREC	West Asia Rinderpest Eradication Campaign
WHO	World Health Organization
WRL	World Reference Laboratory

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