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FAO ANIMAL PRODUCTION AND HEALTH

proceedings

LESSONS LEARNED FROM THE ERADICATION OF RINDERPEST FOR CONTROLLING OTHER TRANSBOUNDARY ANIMAL DISEASES

GREP Symposium and High-Level Meeting
12-15 October 2010

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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Contents

Acronyms

AHA	animal health auxiliary
AU	African Union
AUC	African Union Commission
AU-IBAR	African Union-Interafrican Bureau for Animal Resources
BWC	Biological Weapons Convention
CAHW	Community animal health worker
CBAHW	Community-based animal health worker
CBPP	Contagious bovine pleuropneumonia
CCPP	contagious caprine pleuropneumonia
cELISA	competetive enzyme linked immunosorbent assay
CIRAD	*Centre de coopération internationale en recherche agronomique pour le développement* (International Cooperation Centre of Agricultural Research for Development)
CRP	coordinated research programme
CVO	chief veterinary officer
DfID	Department for International Development
DIVA	differentiation of infected from vaccinated animals
EDF	European Development Fund
ELISA	enzyme linked immunosorbent assay
EMPRES	Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FMD	foot-and-mouth disease
GREP	Global Rinderpest Eradication Programme
HPAI	highly pathogenic avian influenza
IAEA	International Atomic Energy Agency
IAH	Institute for Animal Health
IBAH	Inter-African Bureau of Animal Health
IBAR	Interafrican Bureau for Animal Resources
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IMCAPI	International Ministerial Conference on Avian and Pandemic Influenza
ISU	Implementation Support Unit
JC	Joint FAO Committee for the global eradication of rinderpest
JP15	African Joint Programme 15
MDG	Millennium Development Goal
MINEADEP	Middle and Near East Regional Animal Production and Health Project
NGO	non-governmental organization
NSPFS	National Special Programme for Food Security

OAU	Organization of African Unity
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
PEAC	Post-Eradication Advisory Committee
PPCB	peripneumonie contagieuse des bovides
PPR	peste des petits ruminants
PPRV	peste des petits ruminants virus
RNA	ribonucleic acid
RP	rinderpest
RPV	rinderpest virus
RVF	Rift Valley fever
SAARC	South Asian Association for Regional Cooperation
SAREC	South Asian Rinderpest Eradication Campaign
SERECU	Somali Ecosystem Rinderpest Eradication Coordination Unit
SIDA	Swedish International Development Cooperation Agency
SVS	strengthening of veterinary services
TAD	transboundary animal disease
TCP	Technical Cooperation Programme
TCRV	tissue culture rinderpest vaccine
UN	United Nations
UNDP	United Nations Development Programme
UNICEF	United Nations Children’s Fund
UNRRA	United Nations Relief and Rehabilitation Administration
USAID	United States Agency for International Development
VACNADA	Vaccines for the Control of Neglected Animal Diseases in Africa
VSF	Vétérinaires sans frontières
WAREC	West Asia Rinderpest Eradication Campaign
WFP	World Food Programme
WHO	World Health Organisation

Acknowledgements

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FAO wishes to express its appreciation to all participants for their contributions, and especially to those individuals who attended the symposium with their own resources and whose presence contributed to the overall success of the event.The technical and operational assistance of the following FAO divisions contributed to the smooth running and success of the meetings and is much appreciated: AGA, the Technical Cooperation Emergency Operations Service (TCES), the Office of Corporate Communication and External Relations (OCE), and the Conference, Council and Protocol Affairs Division.

The Global Rinderpest Eradication Programme (GREP) Symposium Secretariat prepared the framework for implementation of the events and is grateful to the facilitators and rapporteurs. Particular thanks to Paul Rossiter, who elaborated these proceedings. The success of these events was possible thanks to the guidance and full support of FAO's Chief Veterinary Officer, Dr Juan Lubroth.

Symposium Secretariat

Félix Njeumi
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Introduction and objectives of the Symposium

A world without rinderpest has been a long-awaited goal. Early reports of simple hygienic measures, such as quarantine and slaughter, stopping the transmission of infection and eradicating the disease at the local level showed that global eradication should be possible. More difficult to achieve, however, were control and eradication where cattle populations were large and mobile and their owners averse to quarantine and slaughter. To combat rinderpest in these populations, vaccines were developed and immediately seen to offer another weapon in the drive towards eradication. Increasingly safe and inexpensive vaccines helped achieve eradication in many parts of Africa and Asia where hygiene alone was insufficient. Unfortunately, however, the virus was often not fully eradicated at the regional level and, time and again, it re-emerged from endemic foci to infect areas previously freed of infection. If eradication was to become a reality, another tool was needed – coordination. For global eradication, this meant coordination across those regions of the world where the virus was endemic: Eurasia and Africa.

In 1992, the Food and Agriculture Organization of the United Nations (FAO) held an expert consultation that recommended the establishment of the Global Rinderpest Eradication Programme (GREP) with the prime purpose of guiding regional and national campaigns towards eradication. GREP was established in 1994 and, after assessing the global rinderpest situation, in 1996 it held technical and expert meetings that provided the framework for a time-bound, epidemiologically based and coordinated final drive towards eradication. The year targeted for achieving eradication was 2010. The global coordination provided by GREP orchestrated the efforts and ideas of regional organizations, national veterinary services and individuals alike, assisting them in identifying areas of high disease risk or uncertainty, and focusing improved vaccine delivery and disease surveillance efforts on these often inaccessible areas. The long-hoped-for and planned result is that cattle plague has been eradicated from the field, throughout the world, since the last outbreak in 2001.

In the proceedings of the GREP meeting held in 1996, *The world without rinderpest*, the introduction states "This will be the first animal disease to be eradicated and it is not an exaggeration to say that, if successful, this would be one of the greatest achievements ever in veterinary science".

The disease has been almost undetected for the last 16 years and completely undetected for the past nine years. FAO, together with the World Organisation for Animal Health (OIE) and others, believes that the virus has been eradicated from Europe, Asia, the Near East, the Arabian Peninsula and all of Africa.

Considering the impact of rinderpest eradication on food security in many countries, and the current rinderpest epidemiological situation, in line with the GREP deadline of 2010, the Director-General of FAO reviewed the situation on the occasion of World Food

Day on 15 October 2010. His statement announced the "end of FAO's rinderpest field operations", thereby declaring that FAO considered rinderpest to be eradicated from livestock and wildlife (while recognizing the ongoing formal process of evidence-based review by a Joint FAO/OIE Committee, leading to simultaneous declarations of global freedom from rinderpest by both organizations in mid-2011).

Prior to the statement of FAO's Director-General, the GREP Secretariat organized the GREP Symposium (13 to 14 October 2010) with the objectives of:

1. drawing lessons from GREP;
2. assessing the economic impact of rinderpest eradication on food security;
3. reviewing/adopting a peste des petits ruminants (PPR) control strategy in the framework of the approach to small ruminant health.

As one of the final acts of coordination against rinderpest, the following proceedings bring together papers and discussions from the organizations and people who brought about this "*greatest achievement ever*", their reviews of what went well and of what did not, and their views on the way forward.

Addresses and messages of welcome and congratulations

SYMPOSIUM MONDIAL SUR L'ÉRADICATION DE LA PESTE BOVINE: ALLOCUTION D'OUVERTURE DU DIRECTEUR GÉNÉRAL

Monsieur le Président,

Mesdames et Messieurs les délégués et observateurs,

Mesdames et Messieurs,

Permettez-moi tout d'abord de vous dire combien j'apprécie votre présence cette semaine à Rome, où nous sommes réunis au siège de la FAO pour prendre part au *Symposium mondial sur l'éradication de la peste bovine.*

La Semaine mondiale de l'alimentation offre un cadre idéal à cet important événement. La lutte contre la peste bovine et son éradication ont toujours figuré parmi les priorités de l'Organisation, qui a pour mission d'éliminer la faim et de renforcer la sécurité alimentaire mondiale.

Cette maladie a sévi en Europe, en Asie et en Afrique pendant des siècles, provoquant des situations de famine générale et décimant des millions d'animaux d'élevage et sauvages. Il y a 250 ans, la France ouvrait sa première école vétérinaire pour combattre ce fléau.

Après avoir causé la mort de près d'un million de bovins en Russie et en Europe centrale dans les années 1880, la peste bovine est apparue en Afrique pour la première fois à la fin du XIXe siècle. Un siècle plus tard, elle faisait encore des ravages dans les communautés rurales de ce continent.

La peste bovine figure en tête des préoccupations de la FAO depuis sa création en 1945. En 1946, la FAO a organisé à Londres une réunion sur la santé animale pour étudier comment il conviendrait de coordonner les activités des organisations vétérinaires à l'échelle planétaire, avec la peste bovine désignée comme la première priorité.

Deux ans plus tard, les participants à une réunion panafricaine à Nairobi débattent des méthodes qui permettraient de juguler la dissémination de cette maladie sur le continent et s'accordent sur le fait que son éradication des territoires africains est une option réaliste, et qu'il faut s'y atteler sans tarder. Pour la première fois, l'idée de l'éradication de la peste bovine est exprimée.

Lors d'une conférence analogue tenue à Bangkok, les gouvernements asiatiques conviennent eux aussi de coordonner leurs efforts de lutte contre la peste bovine en vue de l'éradication.

En 1994, en étroite collaboration avec l'Organisation mondiale de la santé animale (OIE), la FAO lance le Programme mondial d'éradication de la peste bovine, qui forme l'un des principaux volets du Système de prévention et de réponse rapide contre les ravageurs et les maladies transfrontières des animaux et des plantes (EMPRES).

À l'heure où le Programme mondial d'éradication de la peste bovine est sur le point d'atteindre son objectif, à savoir éliminer cette maladie dévastatrice de la surface de la Terre d'ici à la fin de l'année, permettez-moi de souligner que l'extraordinaire réussite de cette initiative n'aurait pas été possible sans les efforts conjugués et la détermination inébranlable des gouvernements de tous les pays touchés et exposés, sans le Bureau interafricain pour les ressources animales de l'Union africaine, sans les organisations régionales compétentes d'Asie et d'Europe, sans les organismes donateurs engagés dans cette lutte.

Je voudrais ici exprimer ma gratitude à l'Union européenne, qui a investi plus de 250 millions d'euros dans l'éradication de la peste bovine dans le monde, dont 200 millions consacrés à l'Afrique par l'entremise de l'Union africaine.

Permettez-moi également de saluer les contributions inestimables des États-Unis, de la République d'Irlande, de la Suisse, de la Suède, de l'Italie, de la France, du Royaume-Uni et de tant d'autres.

La FAO pour sa part a joué un rôle décisif en coordonnant la recherche scientifique, l'élaboration de nouveaux outils de lutte contre la maladie et les campagnes régionales de vaccination. Je citerai, notamment, le Programme conjoint africain 15 (PC15); la Campagne panafricaine de lutte contre la peste bovine à laquelle a succédé le Programme panafricain pour le contrôle des épizooties; le Projet régional de production et de santé animales pour le Proche et Moyen-Orient (MINEADEP); la Campagne d'éradication de la peste bovine en Asie occidentale (WAREC) et la Campagne d'éradication de la peste bovine en Asie du Sud (SAREC), dont les activités se sont ensuite poursuivies avec l'appui de l'Italie dans les pays d'Asie centrale.

Outre la participation de son personnel aux initiatives d'éradication de la peste bovine, financées dans le cadre de son programme ordinaire, la FAO a investi plus de 25 millions d'USD de ses ressources propres. Ce financement est venu appuyer les efforts déployés pour juguler rapidement les apparitions de foyers de peste bovine et promouvoir l'amélioration des capacités diagnostiques des laboratoires, la préparation aux situations d'urgence, la surveillance, les actions de sensibilisation et le renforcement des capacités.

La FAO a également fondé le Laboratoire mondial de référence et d'autres institutions techniques et institutions de recherche, comme le Centre panafricain de vaccins vétérinaires, dont les services sont utilisés par le Bureau interafricain pour les ressources animales. Je note avec satisfaction la force mobilisatrice dont la Commission de l'Union africaine a fait preuve en prenant la tête de cette initiative et en dotant le Centre panafricain de vaccins vétérinaires d'un mandat clair après la cessation des campagnes de vaccination contre la peste bovine.

Le dernier foyer connu de la maladie a été signalé au Kenya en 2001. Toutes les informations disponibles indiquent que le virus a cessé de circuler parmi les animaux d'élevage et sauvages de notre planète. Alors que la FAO et ses partenaires s'emploient à vérifier, d'ici à la mi-2011, que la maladie a bien disparu de chacun des pays, le monde est au seuil d'une monumentale réalisation scientifique: la première éradication mondiale d'une épizootie et la deuxième éradication d'une maladie, après la variole.

Et maintenant?

Maintenant que le monde va se délivrer de la peste bovine, il va falloir garder en place les capacités de surveillance, mais aussi gérer le matériel renfermant le virus de cette maladie, comme les vaccins et les stocks de virus, ainsi que les échantillons contaminés. La FAO entend maintenir et appuyer les activités du Programme mondial d'éradication de la peste bovine, et contribuer ainsi à superviser cette phase essentielle de l'après éradication.

Même si elle n'est pas applicable dans tous les cas, il est à la fois possible et souhaitable d'utiliser la stratégie d'éradication de la peste bovine comme modèle pour d'autres maladies, notamment la peste des petits ruminants (PPR), la fièvre aphteuse ou la péripneumonie contagieuse des bovins (PPCB).

Permettez-moi, pour finir, de saisir cette occasion pour saluer l'engagement et le dévouement de tous les spécialistes, chercheurs opérant sur le terrain et dans les laboratoires nationaux et internationaux, dont l'Agence internationale de l'énergie atomique et les laboratoires de référence partenaires, ainsi que de l'ensemble des équipes des organismes de développement bilatéraux et multilatéraux et des fonctionnaires nationaux qui se sont engagés dans cette lutte. Leur contribution à cette victoire sur la peste bovine est considérable, et tous méritent notre reconnaissance et notre gratitude. C'est ensemble que nous avons vaincu cette maladie, car ensemble, nous sommes plus forts. Et c'est encore ensemble que nous vaincrons la faim.

Je vous remercie de votre aimable attention.

WELCOME ADDRESS TO THE SYMPOSIUM

Dr Modibo Traore
Assistant Director-General, Agriculture and Consumer Protection Department, FAO

Dear colleagues, representatives of OIE, representatives of the African Union-Interafrican Bureau for Animal Resources (AU-IBAR) and the Pan African Veterinary Vaccine Center (PANVAC), directors of the Institute for Animal Health (IAH), the Biological Weapons Convention Secretariat, directors of veterinary services of member nations, distinguished participants, ladies and gentlemen, on behalf of our Director-General, Dr Jacques Diouf, it gives me great pleasure to welcome you to FAO Headquarters and to this major Symposium of GREP.

Since its foundation in 1945, FAO has been combating rinderpest as one of the animal diseases that has affected dramatically the livelihoods and food security of agriculture-dependent communities.

Rinderpest has long been recognized as a devastating, contagious disease of domestic and wild animals, and has a history of epidemics causing significant depopulations of livestock and wildlife in Europe, Asia, the Near East and Africa.

FAO's early involvement was aimed at distributing newly developed vaccine seed viruses; thus, in 1946, an avianized vaccine seed was introduced to East Africa and China under the auspices of the United Nations Relief and Rehabilitation Administration (UNRRA). Subsequently, FAO continued to support national rinderpest vaccine manufacturing centres in the introduction of improved freeze-drying technologies and the use of tissue culture techniques for the production of large quantities of vaccine.

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13 October 2010, Rome - FAO staff members on the presiding panel for the Global Rinderpest Eradication Symposium on the occasion of the 36th session of the Committee on World Food Security (CFS), FAO headquarters (Austria Room).

In 1948, FAO and the United Kingdom Colonial Office organized a pan-African meeting in Nairobi to discuss methods and strategies for containing rinderpest spread in the continent. Participants agreed that eradication of the disease from Africa was a realistic option and should be carried out. This was the first time that the idea of pan-national rinderpest eradication was mentioned.

In 1987, an FAO expert consultation on a global strategy for the control and eradication of rinderpest – convened here in Rome by Dr Yoshihiro Ozawa, who we are very pleased to have with us today – determined that the global eradication of this disease was potentially achievable. FAO was recognized as the appropriate global organization to coordinate the proposed rinderpest eradication campaign and to act as a focus for addressing technical deficiencies and contrasting management methodologies.

In 1989, an expert group meeting in Paris, under the auspices of OIE, concluded that additional international-level safeguards were required for achieving eradication of rinderpest. To be acceptable, field data regarding clinical and sub-clinical disease and serological findings had to be submitted for evaluation from an area where a vaccine was no longer in use. A recommended timetable was introduced, suggesting that the period from the end of vaccination to accreditation of freedom from rinderpest would be only six years. This time-bound element has proved extremely useful at the field level as a tool for revitalizing outdated strategies.

In 1992, another FAO expert consultation recommended that the Organization commence coordination of the global eradication of rinderpest; thus, in 1994, the newly elected Director-General launched the Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases (EMPRES), which included GREP.

Since then, FAO-GREP has worked closely with OIE, its main international partner, to formulate and implement rinderpest control and eradication strategies. This partnership was strengthened in June 2009 with establishment of the FAO/OIE Joint Committee for Rinderpest Global Declaration, some of whose members are here today. Let me take this opportunity to recognize the important contribution made by the committee, led by our colleague Dr Bill Taylor, in ensuring coherence and guiding the two institutions on the road to final eradication of the disease.

GREP also established partnerships with regional organizations, including the African Union (AU), the South Asian Association for Regional Cooperation (SAARC), the Joint FAO/International Atomic Energy Agency (IAEA) Division in Vienna, the Gulf Country Council, reference laboratories – such as IAH in the United Kingdom and the International Cooperation Centre of Agricultural Research for Development (CIRAD, *Centre de coopération internationale en recherche agronomique pour le développement*) in France – and donor agencies including the European Union (EU), the United States Agency for International Development (USAID), the United Kingdom's Department for International Development (DFID), and the Governments of Japan, Italy, Ireland and Switzerland, among others.

In particular, the EU has invested more than EUR 250 million for the global eradication of rinderpest, channelled through FAO, regional organizations and national governments. In Africa alone, through the AU, the EU has invested almost EUR 200 million for programmes such as the African Joint Programme 15 (JP15), the Pan-African Rinderpest Campaign (PARC), the Pan African Programme for the Control of Epizootic (PACE), the Somali Ecosystem Rinderpest Eradication Coordination Unit (SERECU), and others. Elsewhere, FAO and the United Nations Development Programme (UNDP), among others, have supported the Near East Animal Health Institutes' regional project, the Middle and Near East Regional Animal Production and Health Project (MINEADEP), the West Asia Rinderpest Eradication Campaign (WAREC), the South Asia Rinderpest Eradication Campaign (SAREC), several regional/national technical cooperation projects, etc.

Global coordination and inter-organizational cooperation have been fundamental in bringing us to the verge of achieving global eradication of an animal disease for the first time in history. Through these efforts, FAO will ensure further actions before and after eradication and will seek strengthened partnerships in the areas of virus and vaccine sequestration with OIE, the Joint FAO/IAEA Division, AU-IBAR, PANVAC and selected research centres.

In 1994, FAO's designation and provision of support to the United Kingdom's IAH Pirbright Laboratory to function as the World Reference Laboratory made a significant contribution to supporting national and regional control programmes. IAH, together with CIRAD's Animal Production and Veterinary Medicine Department and IAEA, has contributed to the development of diagnostic tests, technology transfers and training of operational staff. In Africa, FAO established PANVAC as a service to AU-IBAR for PARC and PACE, and we thank the EU and the Government of Japan for their support, and also the AU for adopting PANVAC as part of its regular programme, thus guaranteeing sustainability.

Distingués participants,
Mesdames et Messieurs,
Chers collègues et amis,

Grâce aux efforts persévérants de nombreuses générations de chercheurs et de vétérinaires opérant dans les laboratoires, les outils indispensables à la lutte contre la peste bovine ont été forgés et mis en œuvre au rythme des progrès scientifiques. Au moment où nous nous préparons à célébrer la fin des activités opérationnelles de lutte contre cette maladie à l'échelle de la planète, nous devons nous souvenir que notre victoire d'aujourd'hui est avant tout leur victoire; la victoire de la science biologique, médicale et vétérinaire, la victoire des écoles qui ont contribué à la diffusion de ces connaissances à travers le monde.

Mais cette victoire n'aurait jamais pu se réaliser sans le travail acharné, déterminé et souvent ingrat des services vétérinaires de tous les pays, avec leurs bataillons de vaccinateurs, d'infirmières et de vétérinaires praticiens, dont certains malheureusement ont payé de leur vie leur engagement dans ce combat. C'est le lieu pour rendre hommage au courage et à la mémoire de tous ces soldats anonymes, qui dans des conditions souvent extrêmes ont assumé leur devoir et transmis le flambeau de la lutte aux générations suivantes.

Distingués participants, Mesdames et Messieurs, chers collègues et amis,

Les campagnes de lutte contre la peste bovine ont été de véritables écoles pour les générations successives de vétérinaires. Aussi les célébrations d'aujourd'hui n'auraient tout leur sens que si les expériences accumulées tout au long de cette fantastique aventure humaine étaient mises à profit pour affronter de nouveaux défis. Ces expériences sont nombreuses tant au niveau des états individuellement pris que sur le plan de leur coordination au niveau régional et international. Elles doivent inspirer nos futurs combats contre la PPR, la fièvre aphteuse, la PPCB, la trypanosome etc. Une étape importante a été franchie dans la lutte contre les maladies animales transfrontières (TAD). Une nouvelle page de l'histoire s'ouvre. La FAO fonde beaucoup d'espoir sur les conclusions de vos travaux pour contribuer à son écriture.

Je souhaite plein succès à vos délibérations.

Je vous remercie.

WELCOME ADDRESS TO THE SYMPOSIUM

Dr Juan Lubroth
Chief Veterinary Officer, AGA, FAO

Dear colleagues and friends; chief veterinary officers (CVOs); members of the Joint FAO/OIE Committee and members of the OIE ad hoc group on rinderpest; Dr Traoré, Assistant Director-General of the Department of Agriculture and Consumer Protection; Dr Jutzi, Director of the Animal Production and Health Division; Dr Miyagashima, representing Dr Vallat, Director-General of OIE; Dr Taylor, Chair of the FAO/OIE Joint Committee; and Dr Ozawa, former Chief of AGAH and former OIE Regional Representative for Asia: I welcome you to the GREP Symposium commemorating the end of FAO field activities as one of the last steps prior to a global declaration of rinderpest freedom.

We are delighted to have all of you here. I am sure that it is a huge pleasure for you as well as to see colleagues and friends again after so many years and to rejoice at the role and accomplishments you made individually and together to reach this stage before the global declaration.

I have examined thousands of Peyer's patches and hundreds of ileo-caecal junctions over the course of my time in the laboratory as a virologist and in teaching pathology to veterinarians, but today I am humbled by the presence of all of you in this room who did the real work. As Chief Veterinary Officer (CVO) of FAO, I have been contacted for countless comments and interviews on the rinderpest eradication effort, but I realize that I merely represent a long line of dedicated scientists and field workers who devoted their energies and passion to make the eradication of rinderpest possible. Here we are today, and in the next months, harvesting what Dr Ozawa said could be achieved 23 years ago (1987).

I reiterate the gratitude expressed by Dr Traoré in recognizing the donor community. The EU and the European Commission deserve special mention, not only for the funding received for rinderpest prevention and control programmes in Asia and Africa, but also for the partnership and technical expertise they provided.

I strongly believe that without the control of rinderpest or the development of the rinderpest vaccine, the green revolution would not have occurred. Cattle and buffaloes are not only important for the products they produce, but are also essential for tilling the soil, for harvesting and for transporting produce to the market place.

The end of rinderpest also represents a safeguard for numerous wildlife species that succumbed to the devastation.

The end of rinderpest indeed represents one less obstacle to the alleviation of hunger and poverty.

The end of rinderpest is an accolade for the veterinary profession and a lesson for regional cooperation that meets common goals regardless of ethnicity or creed.

Our, or your, accomplishments contribute to attaining the Millennium Development Goals (MDGs).

Thank you.

MESSAGE ON BEHALF OF THE COMMISSIONER OF RURAL ECONOMY AND AGRICULTURE OF THE AFRICAN UNION COMMISSION

Dr Karim Tounkara
Director of PANVAC

Your Excellencies, honourable ministers, dear participants, ladies and gentlemen: Her Excellency Madam Tumusiime Rhoda Peace, Commissioner of Rural Economy and Agriculture of the African Union Commission (AUC) was not able to attend this high-level meeting on rinderpest and beyond owing to other commitments.

On behalf of Her Excellency, I wish to congratulate FAO for organizing this very important meeting. AUC will support all initiatives leading to the reduction of poverty on the African continent. Your meeting is about one of these initiatives: rinderpest eradication.

The AU will continue to provide its technical offices, namely IBAR and PANVAC, with all the necessary means to maintain the status of rinderpest freedom on our continent.

I take this opportunity to express AUC's gratitude to FAO for establishing PANVAC. I can assure you that the AU-PANVAC office will continue to deliver services to the satisfaction of AU Member States and other countries and organizations.

I also thank all donors and technical partners for the support given to the AU during the process of rinderpest eradication.

The Department of Rural Economy and Agriculture will give due attention to the recommendations that come out from this meeting.

I thank you.

ADDRESS BY THE MINISTER OF LIVESTOCK, KENYA

His Excellency Dr Mohammed Kutti

I greatly appreciate being invited to attend and address this symposium. The site where the last outbreak of rinderpest in the world was found is actually very close to my home, so you can imagine how interested I am in the successful eradication of rinderpest. I want to take this opportunity to thank the international community and the patience of the scientists who all contributed to this final outcome. To commemorate this significant achievement, a monument of the buffalo in which the last confirmed case of rinderpest in the world occurred is being erected near the site where it was found and will be officially inaugurated by His Excellency the President of Kenya, Mr Mwai Kibaki on 26 November 2010.

Although rinderpest is now history, we have other serious trade-limiting diseases in Kenya, and a major disease of livestock has newly joined this list. Our first outbreak of PPR was detected in the northwest of the country in June 2006. It spread rapidly because it was not immediately recognized by the pastoralists and, as late as 2008, it was still considered a new disease, with 17 districts affected. After I and my colleagues in the Ministry of Livestock visited the PPR-devastated areas of Kenya, and the government took the decision to vaccinate sheep and goats against the disease. Rapid emergency support from the government provided for 15.2 million vaccinations to be made within a period of two months in a selected buffer zone. This was assisted by FAO and the AU's Vaccines for the Control of Neglected Animal Diseases in Africa (VACNADA) project with another 1 million doses of vaccine. Fortunately, this exercise stopped the further progression of PPR, and by December 2008 the advance had been completely halted. This success showed what can be achieved through a combination of international collaboration and political will.

In Kenya we consider sheep and goats as cash in the pastoralists' pockets, their current account, whereas cattle and camels are their savings account and fixed deposits respectively. It is essential that this new scourge of sheep and goats in Kenya and neighbouring countries is controlled and, preferably, eradicated. I sincerely hope that the lessons learned from the eradication of rinderpest will now be used for a much faster eradication of PPR, and I pledge that Kenya will always be a partner in future disease-control programmes.

ADDRESS BY THE MINISTER OF ANIMAL RESOURCES AND FISHERIES, THE SUDAN

His Excellency Dr Faisal Hassan Ibrahim

Director-General, ministers of livestock, Chairman, ladies and gentlemen: I would like to begin by offering my thanks and appreciation to everyone for the work done and the result obtained. The livestock sector is very important to the Sudan, where it contributes 25 percent of our gross domestic product and provides more than 20 percent of our foreign exchange, consequently supporting the well-being of all categories of our people. Our fight against rinderpest lasted more than 100 years, but with eradication, the battle is finished and we are exporting live cattle again. Our particular thanks go to the Director-General of FAO for facilitating GREP and to its Secretariat for their technical help and vision; and to OIE and AU-IBAR for all their inputs since the early 1960s. We also wish to thank our neighbouring countries and their CVOs and state veterinary services; and the United Nations Children's Fund (UNICEF) and non-governmental organizations (NGOs) for their bridging activities and implementation.

Despite civil unrest, rinderpest eradication in the Sudan was achieved effectively, and the role played by our international partners is acknowledged and much appreciated. The thermo-stable vaccine delivered through community-based animal health worker (CBAHW) delivery systems was widely and very successfully used in the Sudan. The resources and the skills base used to eradicate rinderpest are there to be built on. We now need to move forward on other diseases such as PPR, foot-and-mouth disease (FMD) and Rift Valley fever (RVF). Finally, I wish to thank FAO for convening this meeting and for inviting me to attend it.

MESSAGE ON BEHALF OF THE CHIEF VETERINARY OFFICER OF ITALY

Dr Ghebremedhin Ghebreigzabiher

Thank you Mr Traore for giving me the floor. Thank you also J. Lubroth for your complete and comprehensive presentation, your commitment, your holistic approach, your vision and your clear interpretation of the MDGs, and F. Njeumi for leading the GREP Secretariat. You said you have been quiet for a day and a half, but you and your team have been working hard together and collaborating with all the actors involved to make this meeting possible.

I would like to thank you all on behalf of my Head of Department, Dr Romano Marabelli, who could not be here because he is engaged in a meeting with the Minister.

Italy welcomes the success achieved by GREP and congratulates FAO, OIE and all other actors who made possible this very important achievement – the first animal disease to be eradicated in human history, and only the second disease overall.

It is a great honour for us to participate at such an important meeting, with all the actors who have played a vital role in reaching this achievement of being able to say all together "*Addio* rinderpest".

We would also like to thank the Director-General of FAO, Dr Jacques Diouf, for his kind words of acknowledgement to Italy for its contributions in this eradication process, particularly in assisting the five Central Asian countries of Afghanistan, Pakistan, Uzbekistan, Turkmenistan and Tajikistan.

As you all know, the Italian Government is committed to supporting the actions of FAO and OIE in the fight against transboundary animal diseases (TADs) in Central Asia.

We agree with all who have said that the experience and the know-how gained in eradicating rinderpest must be available to fight and eradicate other diseases, starting with PPR.

The resources are there: human, material, technical, technological, scientific and also a wonderful and functional worldwide network system coordinated by FAO.

Now that we know each other, are partners with a shared common experience and have the knowledge and the system, it is only a matter of deciding: it is up to us to choose which disease to eradicate next.

To all of you who have travelled to be here, I wish you *"buon viaggio*" and "*buon ritorno a casa".*

Looking forward to a common One World, One Health policy in preventing, treating and eradicating diseases, I wish you *"arrivederci a Roma*".

Thank you.

ADDRESS AT THE WORLD FOOD DAY CEREMONY

FAO Director-General

FAO Plenary Hall, Rome, 15 October 2010

Your Excellency Mr Paul Kagame, President of Rwanda, the Honourable Mr Vincenzo Scotti, Undersecretary of Foreign Affairs of Italy, Your Eminence Monsignor Renato Volante, Permanent Observer of the Holy See to FAO, honourable ministers and ambassadors, distinguished guests, excellencies, ladies and gentlemen: this year's celebration marks the 30th World Food Day, a day that has been consistently observed around the world over the last three decades. It was observed for the first time on 16 October 1981, following a United Nations (UN) General Assembly Resolution recognizing that food is a requisite for human survival and well-being and a fundamental human necessity.

Last month, on the eve of the MDG Summit, FAO, jointly with the World Food Programme (WFP) and the International Fund for Agricultural Development (IFAD), released the latest hunger figures to show that 925 million people live in chronic hunger and malnutrition. While this represents a welcome decline from the 2009 level, it remains unacceptably high.

In addition, today 100 countries require emergency assistance to rebuild their agricultural productive capacity, and 30 are in a situation of food crisis. As a consequence, the level of the FAO emergency assistance programme in these countries in now USD 1.1 billion and the programme involves 2 000 experts and technicians.

The continuing high levels of hunger despite abundant global food supplies, better economic prospects and relatively lower food prices point to a deeper, more profound problem. In fact, the present dramatic situation has come about because instead of tackling the structural causes of food insecurity, the world has neglected agriculture in development policies, resulting in underinvestment in the sector, particularly in the developing countries.

14 October 2010, Rome - Press briefing with FAO Director-General Jacques Diouf on the eradication of rinderpest on the occasion of the 36th Session of the Committee on World Food Security, FAO headquarters.

Beyond ensuring food security for the hungry today, food production will need to increase by 70 percent globally and to double in the developing countries, in order to feed a global population expected to reach 9.1 billion in 2050. Population growth will occur entirely in the developing world, where almost all of the undernourished people live. We have resolutely to reverse the long-term negative trend in agriculture's share in official development assistance, which dropped from 19 percent in 1980 to 3 percent in 2006 and is now about 6 percent. Governments of low-income, food-deficit countries should also increase the share of agriculture in their national budgets, from the present average of about 5 percent to at least 10 percent.

Food production gains will need to be realized in the face of several emerging challenges. Urban areas will swell by 82 percent, or around 3 billion people, while the rural population will shrink by 20 percent. This means a smaller rural workforce. Added to this is the increasing demand for agricultural feedstocks for biofuels, whose production more than tripled between 2000 and 2008. Some 100 million tonnes of cereals are diverted from human consumption each year. There is also the impact of climate change on production, with more frequent and severe weather events.

Another threat to food security that calls for special attention is the increasing instability of food markets. Increased price volatility has direct impacts on investment decisions and flows, and falls heavily on poor consumers who spend 50 to 60 percent of their income on food. It also threatens political and social stability. Governments' unilateral decisions to restrict exports tend to aggravate the situation and can lead to increased speculation. There is need for more coherence and coordination in policy choices for greater assurance of unimpeded access to global supplies and improved confidence and transparency in market functioning. Effective tools and mechanisms to deal with food price volatility are urgently required.

15 October 2010, Rome - The President of Rwanda His Excellency Paul Kagame delivering the Keynote Statement on the occasion of the World Food Day Ceremony, FAO headquarters (Plenary Hall).

We also need to guarantee food quality and safety for consumers. We need protection against pests and diseases of plants and animals. We also need to have the capacity to deal effectively with emergency situations resulting from natural disasters.

The durable solution to the food insecurity problem lies in increasing agricultural production and productivity in developing countries and in strengthening their resilience capacity so they can produce the food needed and be more resistant to shocks.

FAO's work shows that the planet can feed itself, provided that concrete and targeted action is taken today to address the multifaceted and root causes of hunger. However, the goal should go beyond simple balances of global needs and supplies. The focus must be on small farmers in low-income, food-deficit countries where the majority of the hungry live and where the bulk of population growth will occur. Income generated by some 500 million small farmers with less than 2 ha of land each supports the livelihoods of about two-thirds of the 3 billion rural people in the world.

Increasing smallholder productivity requires better rural infrastructure, more roads, better access to quality inputs and better technologies for soil and water, improved credit and extension services, more machinery, more implements, and more skilled and better-trained farmers.

We have the global resources, the technology and the know-how to ensure that every human being enjoys the right to food. Many countries around the world, in Africa, Asia and Latin America and the Caribbean, have realized remarkable progress in fighting hunger. This means that we know what should be done to defeat hunger.

We should build on past successes. Earlier, FAO recognized the key role of Dr Norman Borlaug, popularly known as the father of the green revolution for his pioneering and innovative work in Mexico and later India in the 1960s, which – with relevant investment in rural infrastructure and access to modern inputs – led to an unprecedented rise in food production and helped to prevent massive famine. His commitment, dedication and tireless efforts should always serve as a source of inspiration for us.

In fact, 50 percent of the increases in global crop yields achieved between 1965 and 2000 were due to improved plant genetics, and the remaining 50 percent to improved water supply, fertilizers and field crop management practices. Crop production can be increased in a sustainable way by making use of the right kind of policies and ensuring appropriate incentives and income for farmers, but also by adopting the right kind of technologies and approaches. In a few minutes we will see a film on how that can come about.

Responding properly to the hunger problem requires urgent, resolute and concerted action by all relevant actors at all levels. It calls for all of us to be united. Thus the theme for this year's World Food Day is "United Against Hunger". This underlines that achieving food security is not the responsibility of one single party; it is the responsibility of all of us.

The renovated Committee on World Food Security constitutes a major effort in this direction. One key aspect of the reform of the committee is to make it the most inclusive global food security forum for all stakeholders to work together. The participation of Member Nations, the UN system, civil society representatives, NGOs, farmers' organizations, the private sector, international agricultural research centres and international and regional financial institutions offers an inclusive platform for policy convergence and the coordination of action and expertise in the fight against hunger.

Another good example of united efforts to end hunger, which already involves more than 1 million people around the globe, is the 1 Billion Hungry project – an international advocacy and awareness-raising campaign, which with the active participation of UN agencies, NGOs, youth groups, farmers' organizations, the private sector, our FAO Goodwill Ambassadors and other personalities aims to bring pressure on political leaders to take urgent action against hunger and malnutrition.

But perhaps one of the most important achievements of united action is the defeat of the rinderpest disease. Today I am very pleased to announce that we are at the end of the road in achieving the long-pursued goal of global rinderpest eradication. I can now announce that FAO is concluding its field operations and we can expect to declare eradication formally by mid-2011, together with OIE. This is the first time that an animal disease has been eradicated in the world, and the second disease in human history after smallpox.

Rinderpest affected Africa, Asia and Europe for millennia, causing widespread famine and decimating millions of animals, both domestic and wild. In the period from 1980 to 1984 alone, the estimated direct losses in Africa resulting from the disease amounted to USD 500 million.

As GREP, which was initiated in 1994, stands on the verge of achieving its goal of wiping out this devastating disease, allow me to recognize that the extraordinary success of this programme would not have been possible without the united efforts and strong commitment of the governments of all affected and exposed countries, without AU-IBAR and the responsible regional organizations in Asia and Europe, and without donors' continuous support. I wish also to take this opportunity to thank all those individuals who have invested their time and professional lives into this highly significant effort.

In the current context of difficulties and challenges, it is the shared responsibility of all actors to meet the needs of the hungry and poor, and also the hopes of the founding fathers of this Organization. Having 925 million of our fellow citizens suffering from hunger on a daily basis cannot leave us indifferent. It is outrageous. We have to join hands to realize our common goal of a food-secure world.

I am convinced that, united we can defeat hunger.

I thank you for your kind attention.

Summary report of the meetings

INTRODUCTION

FAO has a long and successful history of fighting rinderpest. It has played a global coordinating role from its inception and operated its first field campaign in late 1940 in China. Since then, it has worked continuously in the field in Africa, Asia and the Near East, assisting member countries in implementing vaccination campaigns, supplying vaccine and other materials and equipment, and providing training and technical assistance. For the past 16 years, through GREP, FAO has also provided coordination and other support for the final intensive stages of global eradication. With increasing effect, co-coordinated regional campaigns have identified and eliminated the few remaining foci of infection in Africa and Asia, and the last confirmed case of rinderpest in the world was in 2001. Since then, all continuing surveillance for disease and for virus has failed to find any evidence that rinderpest is occurring naturally anywhere in the world. In view of this, FAO has decided to stop its operational field activities against rinderpest some 65 years after starting them. Thus, GREP, established in 1994 as a component of EMPRES, has successfully achieved its original objective of helping to eradicate globally this most disastrous animal disease by 2010. With the purpose of documenting and celebrating this remarkable programme success, the following series of four events was organized by the GREP Secretariat during World Food Security Week at FAO, from 12 to 15 October 2010.

The expert workshop (12 October 2010)

Through GREP, FAO will continue to work with OIE on a number of aspects of a global post-eradication strategy that will ensure the secure sequestration of remaining laboratory stocks of virulent and attenuated rinderpest virus and continuing vigilance against the risk of inadvertent or improper release of virus from such stocks. The expert workshop aimed to begin formulating a strategic plan for all post-eradication requirements, including post-eradication risk monitoring, sequestration of all stocks of virus, and the collection for posterity of all documentation on rinderpest and its eradication. In attendance were members of the FAO/OIE Joint Committee for Rinderpest Global Declaration and of the OIE rinderpest ad hoc group for evaluating country evidence.

The main output from the workshop was a clear understanding of what is required of the post-eradication strategy for rinderpest. Detailed accounts of the outputs were presented at the Symposium and are included in the proceedings. A post-eradication strategic plan must address biosecurity through virus audit and sequestration, risk analysis, contingency planning and continued surveillance, as well as the final stages of the verification of global eradication. The plan is intended to be annexed to the formal resolution on rinderpest eradication scheduled to be adopted by the FAO Conference in June 2011.

The Global Rinderpest Eradication Symposium

The Symposium was convened to celebrate the eradication of rinderpest worldwide and to draw lessons from this successful GREP-led programme. With support from the European Commission (project GCP/GLO/302/EC) and other sources, FAO brought together nearly 100 animal health scientists and other specialists from some 40 countries. Participants included senior administrators and managers from international and regional organizations, senior national field staff from countries that have played important roles in eradication, individual scientists and veterinarians who have made key contributions, and senior staff of FAO. The Symposium reviewed the overall history and roadmap that led to rinderpest eradication, highlighting and recording the important lessons learned and assessing the economic impact of rinderpest eradication on food security. The opportunity was also taken to see how the lessons learned could be applied to other diseases, especially PPR, a disease of sheep and goats caused by a virus closely related to rinderpest virus, with similar epidemiological characteristics and distribution.

The participants presented a series of papers grouped into six broad categories: the three principle areas of coordination and effort leading to global control – global, regional and national; the experiences of key individuals; an update on progress on the post-eradication strategy; and potential application of the lessons learned to the control of PPR and other diseases. The papers and discussions that followed them form the main body of these proceedings, and a synopsis of their main findings in relation to the three objectives of the Symposium is given in the following section.

The high-level meeting

The high-level meeting was attended by the Director-General of FAO, very important guests who had been invited, and participants of the Global Rinderpest Eradication Symposium. Its purpose was to celebrate and share the success of rinderpest eradication, report the outcomes of the Symposium by highlighting particular success stories, and communicate FAO's post-rinderpest eradication strategy and future animal health strategy.

The meeting was addressed by the Director-General of FAO, the Minister for Livestock of Kenya and Minister of Animal Resources and Fisheries of the Sudan. A message from the AU's Commissioner of Rural Economy and Agriculture was delivered on her behalf by the Director of PANVAC.

FAO's CVO, Dr Juan Lubroth, recounted FAO's contribution to rinderpest eradication and the events leading to the cessation of field activities. He summarized the main outputs from the previous two days of deliberations, particularly the lessons learned during the process of eradication, and the Symposium's recommendations to FAO.

Using data from the JP15 campaign against rinderpest, Dr Joachim Otte presented a paper co-authored with Dr Rich that examined the likely benefits accruing from rinderpest eradication. This paper, which is discussed in more detail in the following section and is included in the main proceedings, showed convincingly that eradication offers better economic returns than continual control and that the extra costs incurred for the eradication programme had been repaid more rapidly than might have been predicted. The authors conclude that eradication is a viable economic alternative when considering long-term strategies for combating some diseases.

The CVO of FAO then outlined the ongoing evolution of a new broad vision for FAO's animal health programme. Central to this is an increasingly integrated and holistic approach that aims to position animal health within the context of contemporary global views on the management and utilization of farm animals, while balancing these with the needs of the poorest livestock keepers.

The announcement by FAO's Director-General

The culmination of the week's events was the announcement by the Director-General of FAO in his World Food Day address on 15 October that "FAO is concluding its field operations and we can expect to declare eradication formally by mid-2011, together with OIE."

The Director-General's address stressed the overwhelming need for everyone to help fight against the hunger that affects nearly 1 billion people worldwide each day. In this fight he emphasized the importance of united action by all involved if there is to be a successful and rapid outcome. Building on this theme he used the occasion to announce the global eradication of rinderpest from the field as an example of the kind of benefits that can be achieved by united action such as the coordinated programmes under GREP. The complete text of the Director-General's statement on rinderpest is given in the first section of these proceedings. The World Food Day ceremony was attended by all Symposium participants, for whom the statement on rinderpest was the long-awaited culmination of years of work and aspiration.

FINDINGS OF THE SYMPOSIUM

Lessons learned

The papers range widely over topics such as management and coordination, funding, political commitment, laboratory support, economics, epidemiology, the role of wildlife, training and capacity building, vaccines, the concept of eradication versus disease control, and community-based techniques. Other papers consider the post-eradication strategy and the current knowledge of PPR and possible approaches to its control and future eradication. Nearly all of the papers cite lessons learned and, despite the diversity of issues addressed, these are consistent and cross-cutting. They fall into three main categories: institutional, operational and scientific.

Institutional lessons: The single most consistently mentioned lesson in virtually all papers is that *good coordination and partnerships* were the keys to final success. Not surprisingly, there are no dissenting opinions. Coordination worked at the global, regional and national levels, and successful partnerships were built among international agencies, between international and regional agencies and between these bodies and national agencies, particularly State veterinary services. Other successful partnerships included laboratory and surveillance networks. Considerable support was shown for public-private partnerships in which private veterinary practitioners working under "*mandats sanitaire*", and sometimes with CBAHWs, cooperated with State veterinary services to implement the actions required to eradicate rinderpest.

Another vital lesson is that success is more likely with *sustained political and financial support*. In several countries, significant progress came only after political acceptance that rinderpest existed in the country and that it was in the country's best interest to eradicate the disease as soon as possible. Once this decision was made, eradication in these countries often followed sooner rather than later and with fewer complications than foreseen. Long-term support from donors is seen to have been crucial to achieving eradication, and the very considerable and enduring contribution of the EU and the European Commission is appreciated in many papers.

Effective *implementation of a post-eradication strategy* is seen as being essential for the future, and will best be coordinated through global players such as OIE and FAO-GREP, which will continue for the foreseeable future.

Operational lessons: Successful operations require well-designed national strategies built on *epidemiological knowledge* of the local situation, *realism* about what is and is not achievable, and *sufficient resources* to implement the strategies through to completion. Where *specific livestock ecosystems* were implicated in the persistence of virus, *regionally based approaches* among the countries involved worked well and are seen to be appropriate models for future programmes. The *strengthening of veterinary services* that was widely promoted after JP15 is seen to have been essential to developing the capacity required for achieving eradication, particularly disease and virus surveillance capabilities, early detection and early response systems, and community-based involvement at all levels, including in vaccination and disease reporting. However, there is concern that in some countries this strengthening will require *continuing external support* before it can be self-sustaining.

Most of the papers look forward to using the *skills, resources and confidence* built into the national and regional programmes for rinderpest eradication, and applying them to the control and possible eradication of other diseases. This will require *continuing global and regional coordination* and, for many countries, continuing *external financial support*. The *opportunity* to use these new strengths should not be missed because they are too valuable to be lost. More than half the papers *identify PPR as the priority disease* for becoming the focus of a global programme, and this was reinforced during discussions. The broadly overlapping distribution of PPR outbreaks and veterinary services that have been strengthened under rinderpest eradication programmes provides the opportunity for using the skills and confidence that were developed. The choice of PPR is guided not only by its close virological and epidemiological similarity to rinderpest, but also by its current relevance as a serious epidemic disease that is spreading rapidly in Africa, Asia and the Near East. In addition, PPR's impact on small ruminants, which are now recognized as being essential to *poverty alleviation and food security* among the world's poorest farmers, cannot be ignored. It is widely agreed that any future campaign or programme would be most effective if embedded in a larger programme of improved small ruminant health tailored to specific epidemiologic and community needs.

Community involvement at all levels is seen as a core component of any future programme and should be ensured from programme inception through to completion and evaluation. To get the fullest community support for future programmes, it is recommended that maximum *publicity be given to GREP's success* and what this means for livestock owners and the wider society. Publicizing this success should also help to encourage future support of the animal health sector from both *traditional and new donors*. One aspect of GREP's success is that it has put global eradication firmly on the map as a tool to be considered for other diseases. Only a few other diseases may lend themselves to this solution, but having achieved success with rinderpest, eradication is no longer just a concept.

As one of the discussants said "this is, in a way, a starting point. The basic structures and collaboration are there and must be kept to tackle other [diseases]".

Scientific and technical lessons: Rinderpest had *suitable scientific characteristics* that lent themselves to eradication, and more than one paper notes that the disease was eradicated from many countries without mass vaccination campaigns. Nevertheless, these and other papers also emphasize the importance of good vaccination as the main means of achieving control. In this respect, the efforts made to ensure that only *quality-controlled and standardized vaccines and laboratory tests* were used throughout the programme ensured reliability and comparability of results, built confidence, and contributed significantly to the final outcome. The various *networks* and collaborative initiatives that provided the *training and technology transfer* necessary for the successful use of these techniques in the field are considered very important to the overall success of GREP.

A number of papers report on the different *ways in which vaccination* was used in the different campaigns leading to final success. Together, they provide a valuable review of how vaccination *evolved* from mass vaccinations in JP15, in which all animals were inoculated up to three times in their lifetimes, to the once or twice of PARC's early stages, and finally to epidemiologically focused campaigns in India and PACE, in which only animals known to be at high risk were inoculated. Within these focus areas, newer approaches such as *immunosterilization* and *community-based vaccine delivery* with *heat-tolerant vaccine* then made a valuable contribution in South Sudan. Noting that future control campaigns against PPR may require even more vaccination than did rinderpest, several participants advocate the use of more modern approaches from the start and suggest that additional *innovative thinking* for epidemiological targeting and vaccine delivery may be necessary.

The impact of rinderpest eradication on food security

Two papers, one in the Symposium and the other at the high-level meeting, report that insufficient attention was paid to the food security aspect of the eradication programme. The general lack of suitable information and data does not allow for easy *post-factum* analysis. Thus, a major lesson learned is that all future control and eradication programmes should have in-built economic assessment or evaluation components. Both papers also note that the economic analyses that were carried out tended to concentrate on some of the more straightforward financial aspects of rinderpest eradication, such as numbers and values of animals surviving, and control costs saved. A more complete accounting of the total benefits accruing from eradication would require a broader socio-economic assessment, including detailed consideration of a wider number of first-, second- and third-round effects. Another lesson is therefore that future disease control programmes should include components for economic assessment involving a wide array of metrics that go beyond the relatively easy-to-measure indicators of livestock performance and financial expenditures.

As an example of this broader socio-economic approach, Drs Otte and Rich explore data from pre-JP15, JP15 and PARC campaigns in the West African countries of the Niger, Nigeria and Chad. Their analyses show the strong causal relationship between intensified vaccination campaigns aiming for eradication and the decline and local eradication of rinderpest. However, the same data also show the return of the disease when total eradication was not achieved regionally or globally and when external support for maintaining local vaccination and follow-up measures ceased. Comparing the expected cost of rinderpest under a pre-JP15 scenario with that under PARC they show how the cumulative costs of open-ended routine control without eradication soon equal and then exceed the costs of an eradication campaign, even though the latter has higher initial costs for the required mass vaccination and other measures. They conclude "there can be little doubt that investment in rinderpest eradication outperformed most alternatives in disease control." Given the close correlation between economic development and food security, and cattle's large economic contribution in predominantly agrarian economies, enhanced food security (albeit unquantified) is a major benefit of rinderpest eradication – a very positive lesson.

Applying lessons learned to small ruminant health and PPR

The papers on PPR support GREP's proposal for applying the lessons learned from rinderpest eradication to the eradication of PPR. However, they caution that less is known about PPR than was known about rinderpest at the start of GREP, and PPR differs from rinderpest in several ways, which at least initially could make eradication more difficult. It would therefore be prudent to apply the lessons learned from rinderpest eradication to progressively improving the control of PPR and then, if this is successful, to reassess how best to make the switch from control to eradications. Dr Libeau reports on the rapidly increasing geographic distribution of PPR and the former interrelationship between PPR and rinderpest in the field. Her paper argues that as the host range of PPR virus appears to be widening, and as rinderpest virus and cross-protective rinderpest antibodies have both been eradicated, cattle are now a susceptible host for PPR virus. Serological evidence shows that cattle are frequently infected by this virus, but so far do not sustain the infection for prolonged periods. The paper discusses the ability of morbilliviruses to mutate and the possibility that PPR might adapt itself to cattle, perhaps causing disease in this species too. Although the paper goes on to show that this may not be imminent, the prospect of eradicating rinderpest from cattle only for rinderpest to be replaced by PPR is surely sufficient justification for seriously considering the improved control and possible eradication of PPR.

RECOMMENDATIONS

1. The successful global eradication of rinderpest should be widely publicized, including:
   - the roles played by all stakeholders, including livestock owners;
   - the benefits that eradication has brought and will continue to bring for individuals and for the economy at large;
   - the lessons learned during the eradication process, and their potential application to other diseases;
   - the post-eradication strategy, including monitoring, the sequestration of all stocks of virus, and documentation of the eradication process.
2. International and regional organizations and all stakeholders should apply the lessons learned from the eradication of rinderpest to other diseases, particularly the progressive control and eventual eradication of PPR. FAO should play a leading role in organizing the preliminary steps necessary for initiating this global initiative and in identifying appropriate partnerships for driving and implementing the activities required.

Global experience

Chaired by Dr Juan Lubroth

GLOBAL RINDERPEST ERADICATION: THE ACHIEVEMENTS OF FAO AND GREP

Félix Njeumi
GREP Secretary, EMPRES, AGAH, FAO, Rome

The role of rinderpest in the birth of FAO

FAO's gestation began in the 1930s under the auspices of the League of Nations in Geneva. Its birth was induced at a Conference on Food and Agriculture in May and June 1943, held at Hot Springs, Virginia, United States of America, which appointed an interim commission to work out a constitution for a permanent organization. In 1945, when the United Nations succeeded the League of Nations, FAO was one of the first specialized agencies to be established. Sir John Boyd Orr was elected Director-General of the new organization at the first FAO Conference, held in Quebec, Canada, in the autumn of 1945. Within a year, FAO convened a meeting in London on animal health, to consider how the activities of veterinary organizations all over the world could best be coordinated under its umbrella, with particular attention to mitigating the widespread ravages of animal plagues. Rinderpest was at the top of the list, and has continued to dominate the agenda ever since.

The League of Nations' under the United Nations Relief and Rehabilitation Administration (UNRRA), which ceased after the Second World War, worked out an agreement with the would-be FAO whereby the latter assumed responsibility for UNRRA's agriculture advisory projects in nine countries: Australia, China, Czechoslovakia, Ethiopia, Greece, Hungary, Italy, Poland and Yugoslavia. When FAO took over from UNRRA with a residual fund of USD 1 135 000, the most extensive and varied operations were in China and Ethiopia, and rinderpest control was the most important part of its programmes. FAO's first role was to help develop improved, sufficiently low-cost vaccines for extensive rinderpest control operations. For the first time, there was hope of eradicating this disease (FAO, 1945a; 1945b; Kesteven, 1949).

GREP

Since its establishment in 1994, FAO's EMPRES has played a major role in fighting the persistence and/or spread of TADs at the global and regional levels, with an emphasis on endemically infected countries. One of the most important EMPRES activities has been GREP, a time-bound programme that was established with the aim of ensuring global eradication of the rinderpest virus by 2010. It should be noted that as rinderpest is a trade-restricting disease, determination of its eradication has required elimination of the virus from domestic livestock populations, followed by the collection and independent evaluation of clinical and serological surveillance data at the national level, to demonstrate the cessation of virus circulation. Developing an understanding of the epidemiology of the virus was an adjunct to eradication, and the GREP Secretariat focused its activities on facilitating:

- development of appropriate disease surveillance techniques;
- support to national laboratory services in organizing intensive and sustained surveillance programmes;
- assistance to national veterinary services in conforming with OIE guidelines for declaring freedom from disease and infection;
- articulation of an effective strategy for preventing or responding to the reintroduction of rinderpest virus;
- development of effective national/regional emergency plans, including a rehearsed action programme in case of an outbreak;
- promotion of high-quality vaccines independently tested for efficacy and safety;
- safeguarding the virus from misuse and accidental escape from laboratories or vaccine manufacturing facilities;
- when epidemiologically appropriate, assisting the coordination of focused vaccination campaigns leading to the verifiable elimination of persistent endemicity.

Target achieved: GREP was successful. It achieved its stated objective of coordinating the eradication of rinderpest virus by an established deadline, demonstrating how practical reality can complement scientific feasibility. Eradication was achieved even though animal movement control and quarantine were virtually absent in many areas that are now disease-free. GREP was successful in eliminating the virus within less than 15 years from six known or suspected enclaves of infection: Afghanistan-Pakistan; China-Mongolia-the Russian Federation; Iraq-the Syrian Arab Republic-Turkey; Saudi Arabia-Yemen; South Sudan; and the Somali ecosystem. Rinderpest was last detected in Kenya in 2001. The last use of rinderpest vaccine was in 2006. Continuing surveillance has detected suspect cases of rinderpest since then, but all investigations have failed to find any evidence of the virus.

FAO's role in vaccine production and distribution and in vaccination

In its early phase, FAO helped to develop improved vaccines sufficiently low in cost for extensive rinderpest control operations. The first large-scale testing ground was China, where FAO continued the work begun by UNRRA. Chinese technicians were trained in the use of modern equipment for vaccine production, and a large-scale control programme was initiated. At the time, it was reported that rinderpest was killing up to a million animals a year in China (FAO, 1945a). The first recommendation of the Subcommittee on Animal Health of the FAO Standing Committee on Agriculture, issued in April 1947, was that FAO should assist in the distribution and establishment of the then-novel, attenuated avianized rinderpest virus vaccines developed by the United States of America and Canada at Grosse Isle. 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 Nakamura's lapinized rinderpest vaccines. The Chinese authorities preferred working with the Nakamura strain, attenuating it further through adaptation to sheep. No outbreak has been reported from China since the late 1950s. At the end of April 1948, one of the two veterinarians, Dr K.V.L. Kesteven, was appointed to FAO's staff in Washington, DC, primarily to work on the problem of rinderpest.

Later in the same year, FAO and the United Kingdom's Colonial Office organized a pan-African meeting in Nairobi specifically to discuss methods of controlling rinderpest. The African Rinderpest Conference, examining the question of eradication in Africa, drew attention to the special problems that existed in certain territories – the Sudan, Eritrea, Ethiopia and Somalia – and envisaged that assistance might be required in the spheres of finance and the provision of personnel and vaccines. The conference recognized that overstocking would increase as control of rinderpest progressed. In view of this danger, the conference stressed that the marketing and utilization of surplus stock was imperative. Finally, the African Rinderpest Conference considered that FAO would be the most suitable global organization to consider solutions to these problems (FAO, 1945a; Kesteven, 1949). Supported by FAO, the eminent Japanese virologist, Dr Junji Nakamura, advised the Governments of Egypt and Nigeria on the production of rinderpest vaccine, and Dr S.A. Evans similarly advised the Sudan Government. FAO convened a similar Rinderpest Conference for Asia and the Far East in Bangkok, at which several governments agreed to take all possible steps to produce vaccines and to control rinderpest while coordinating their programmes with those of neighbouring countries, with the ultimate objective of eradication.

In the 1950s, FAO supported the use of the more attenuated lapinized and lapinized-avianized vaccines originally developed by Dr Nakamura using the virulent Fusan strain of the virus (FAO, 1964). At the historical level, we should note that as early as 1926 J.T. Edwards had begun to attenuate an Indian rinderpest strain, hill bull virus, in goats, eventually leading to a goat-adapted vaccine that was easier to amplify than lapinized virus and was in regular use in India from 1953 to 1973.

Working with the virulent Kabete O strain of the virus, workers in Kenya mirrored the work of Edwards and attenuated this virus in goats, leading to a product known as Kabete attenuated goat vaccine. This strain became widely accepted throughout Africa in the 1950s and up to the first phase of JP15. Working at the East African Veterinary Research Organization at Muguga, Kenya, Dr Plowright and his co-workers isolated the virulent Kabete O rinderpest virus in cell culture and then attenuated the virus through repeated cell culture passage to produce, in 1959, the live cell culture vaccine that proved to be the main tool in the battle for controlling rinderpest worldwide (Plowright and Ferris, 1962). In the 1960s, FAO instigated the foundation of the Near East Animal Health Institute, with a rinderpest unit established in Cairo equipped to diagnose rinderpest and produce rinderpest cell culture vaccine. Using this vaccine, a major success was the virtual eradication of rinderpest from the Near East after a pandemic swept across the region in late 1960. Control procedures in affected countries were coordinated by Dr K.V. Singh, the FAO Regional Rinderpest Laboratory Coordinator stationed in the Near East Animal Health Institute in Beirut (FAO, 1964). Training sessions were held in 1965 in Cairo, on the production of rinderpest cell cultured virus vaccine, and in 1966 in Mukteswar, India, on the diagnosis of rinderpest. In 1970, FAO recommended that the cell culture vaccine should be used in all the countries of the Near East and South Asia.

Coordination of the rinderpest eradication campaign

Strong regional and global coordination provided scientific and operational direction and constant encouragement to national programmes. Although it had been suggested previously, it was only during the FAO expert consultation held in Rome in 1992 that regional coordination of campaigns was confirmed as the only realistic approach to rinderpest control. It was argued that national actions could lead to only temporary improvements unless livestock populations were isolated from one another. FAO fostered the concept of a coordinated African regional programme (JP15); the Near East Animal Health Institute's regional project, MINEADEP; PARC; SAREC; and WAREC. PARC was followed by PACE and SERECU, in whose area of activity the last circulation of virus was reported. SAREC was succeeded by a project in Central Asia funded by the Government of Italy.

Establishment of veterinary services

In 1948, FAO took over an UNRRA programme to help build Ethiopia's capacity for animal health. As a priority, the project paid particular attention to rinderpest control because of the country's large cattle population. It was necessary to establish and/or strengthen all aspects of the veterinary services, including support to laboratories, training of field and laboratory staff, and assisting the government in organizing a systematic control programme. In the late 1950s, Dr H.B. Shaki established a veterinary service to combat rinderpest in Nepal. Ten years later, a fresh rinderpest invasion of Nepal was curbed by the organizational skills of Dr C. Seetharaman.

More recently, FAO assisted the veterinary services of countries with rinderpest in eliminating the disease, halting vaccination and providing evidence of absence of the virus through clinical disease search, serological surveillance, contingency planning and laboratory support. The GREP Secretariat also contributed to OIE's standard-setting activities. 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 over the past 65 years.

Donors support and partnerships

Substantial and enduring financial support underwrote the resources and resolve needed to achieve eradication. For the most part, donor assistance came from the European Development Fund (EDF), UNDP and a number of individual countries including Canada, France, Germany, Ireland, Italy, the United Kingdom and the United States of America, as well as the infected and at-risk countries concerned.

FAO itself has also been a substantial donor to rinderpest eradication, contributing more than USD 45 million of its own funds over the last 30 years, mainly through its Technical Cooperation Programme (TCP). Specific TCP projects supported important technical goals, such as the establishment of PANVAC in Ethiopia, the strengthening of laboratory diagnostics, and emergency preparedness planning. Emergency TCP projects played a vital role in helping countries to counter new outbreaks of disease when other funding was less readily accessible. For instance, during the last African rinderpest pandemic (1980 to 1983), FAO invested more than USD 5 million to control the disease in 17 countries in sub-Saharan Africa. The disease was not reported in several of these countries after FAO's intervention.

GREP continues to work in partnership with OIE and specialized regional organizations such as AU-IBAR and SAARC.

In the period following eradication, FAO and OIE will continue to collaborate on the development of a global contingency plan and on ensuring the safe sequestration of residual laboratory virus stocks.

Laboratory and epidemiology networks

FAO recognized a number of regional reference laboratories with sufficient technical expertise in the diagnosis and surveillance of rinderpest to be able to offer a regional service to neighbouring countries. In the 1980s, the Joint FAO/IAEA Division based in Vienna initiated a laboratory network of experienced scientists with links to the FAO Animal Health Service section responsible for infectious diseases (which later became EMPRES). This network contributed to a dramatic improvement in information gathering, laboratory proficiency, surveillance for disease, and monitoring of vaccination efficacy and coverage in both national and reference laboratories. The network was a valuable forum in which to discuss and analyse data and provide information that national veterinary services and others could use to assess rinderpest disease status nationally, regionally and globally. Veterinarians were trained in epidemiology, including the use of software developed by FAO for information collection and sharing.

Tools developed and applied

FAO advised on, promoted and helped assess many of the tools and techniques that were successfully used for eradication. These included the scientifically based guidelines developed with OIE to provide a pathway for countries to follow to achieve eradication; quality assurance of vaccine and serological tests; the heat-tolerant version of the cell culture vaccine that facilitated vaccine delivery to inaccessible areas that were beyond the reach of cold chains; risk-based surveillance, participatory disease search techniques and computer modelling; and contingency planning for rinderpest. Other technical assistance included the formulation of surveillance strategies, field surveillance, the provision of diagnostic kits, and help in preparing national dossiers in support of recognized freedom from rinderpest. The skills and materials needed for the eradication of rinderpest remain available for the control of other diseases.

Meetings

Since its foundation, FAO has convened more than 1 000 meetings and workshops at the national, regional and global levels, covering all aspects of the control and prospective eradication of rinderpest.

FAO/OIE Joint Committee for Rinderpest Global Declaration

The global eradication of rinderpest requires that the international community establish an inventory of existing rinderpest virus stocks to prevent re-emergence of the disease through release of rinderpest virus from laboratory sources. To this end, FAO and OIE, through the Joint Committee, have committed themselves to establishing the principles for international oversight and regulations for facilities holding materials containing rinderpest virus. Specific guidelines are being developed to ensure secure handling and sequestration of rinderpest virus in the post-eradication era. Additionally, countries are encouraged to reduce the number of rinderpest virus repositories under official supervision, to minimize the risk of accidental release. The committee will deliver a comprehensive report of its findings to the Directors-General of both FAO and OIE following a review of all documents and data related to all claims of rinderpest freedom. The GREP Secretariat serves as Secretariat to the Joint Committee.

Formulation of a strategic plan for the post-eradication era

Together with OIE, FAO is developing a strategy for managing rinderpest after eradication. The components of this strategy include contingency planning for unexpected outbreaks, auditing and sequestration of all remaining infectious rinderpest virus, and a historical account of the disease and its eradication. Contingency planning activities that have either commenced or are foreseen include a survey of all biological materials that might contain infectious rinderpest virus; designation of laboratories where vaccine might be banked for possible emergency use; designation of laboratories where diagnostic capacity must be maintained; designation of laboratories where virulent rinderpest virus is stored; clear direction on the conditions under which rinderpest virus may be used for scientific study; various mechanisms to ensure continuous and sensitive surveillance for rinderpest; and training to create pools of professional staff capable of recognizing and combating rinderpest. Preparing an inventory of all stocks of live virus, both attenuated and virulent, has begun, as have the initial stages of preparing the historical account of rinderpest and its eradication.

Within the framework of the strategic plan, it is recommended that OIE and FAO jointly establish an advisory body to: i) advise the Directors-General of both organizations on the approval of facilities for holding material containing rinderpest virus and of facilities that produce and/or hold rinderpest vaccines; ii) advise the Directors-General on the approval of requests for research and other manipulation of rinderpest virus; iii) review the plans and results of regular site visits to virus repositories; and iv) provide relevant advice to the Directors-General in related areas.

Another post-rinderpest eradication activity being under taken by FAO is to maximize the opportunity presented by GREP's success to redirect attention and resources to other diseases that are open to progressive control and eradication. PPR has been identified as a possible candidate for this, and GREP is developing a control/eradication strategy for this disease, for consideration.

Conclusion

Rinderpest has not been detected since 2001; in 2010, FAO is confident that the virus has been eliminated from Europe, Asia, the Near East, the Arabian Peninsula and Africa. This has been a remarkable achievement for veterinary science, and provides evidence of national commitment to a public good, as well as being a victory for donors and the international community. Today, the lessons learned can be applied to other diseases such as PPR, FMD, contagious bovine pleuropneumonia (CBPP) and sheep and goat pox. A major programme against these diseases could start immediately, with funding and institutional coordination.

FAO is justifiably proud to have played a constant and central role in the eradication of rinderpest. It is expected that GREP will be continued in the post-eradication era, ensuring technical support for the proposed post-eradication strategy and developing new animal health initiatives for improving world food security.

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GLOBAL RINDERPEST ERADICATION: THE LESSONS LEARNED BY THE FAO WORLD REFERENCE LABORATORY FOR MORBILLIVIRUSES, IAH PIRBRIGHT

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Introduction

The Institute for Animal Health (IAH) Pirbright was designated the FAO World Reference Laboratory in 1994, and thereafter provided a global diagnostic service for all countries involved in GREP. This included rinderpest diagnosis, serology, molecular characterization of viruses, provision of training and technical backstopping, production and quality control of diagnostic kits, and research to further the understanding of rinderpest virus. IAH encourages close links between research teams and the providers of diagnostic services. This results in synergy with both disciplines strengthening each other. The research teams produce new technologies and reagents, such as the reverse-transcriptase polymerase chain reaction (PCR) developed by Tom Barrett, which was used with such good effect in diagnosis and in all molecular characterization studies. In return, the research teams benefitted from improved diagnostic tools and a supply of field strains for their nucleotide sequence databases. Experimental infections in large animals furthered understanding of the immune response and clinical manifestations following infection with mild strains of rinderpest virus, as well as providing useful diagnostic antisera and diagnostic samples with which to validate newly evolving assays.

Lessons learned

The main factors in the success of GREP from an IAH perspective were:

- development of appropriate technology;

- successful technology transfer and technical backstopping;
- provision of standardized diagnostic kits.

Appropriate technology: The live attenuated cell culture vaccine induces life-long immunity after a single vaccination, but only if the freeze-dried vaccine has been maintained at the correct temperature before administration. The virus is rapidly inactivated at temperatures greater than 4^0C. Because of the high ambient temperatures in most countries involved in GREP, this involved the strict use of a cold chain. Sero-monitoring was essential for monitoring the vaccination teams' performance and establishing the level of herd immunity. At the start of PARC and GREP, few laboratories were able to carry out the virus neutralization test, and analysing the large number of sera required would have been almost impossible. An indirect enzyme linked immunosorbent assay (ELISA) was developed (Anderson *et al.,* 1982; Anderson and Rowe, 1983) and given a two-year field trial in the United Republic of Tanzania to ensure it was suitable for use under local conditions. It worked well and was introduced into the Rinderpest Laboratory Network established by the Joint FAO/IAEA Division. Later, it was replaced with a monoclonal antibody-based competitive ELISA (cELISA) (Anderson, McKay and Butcher, 1991), which gave greater specificity, sensitivity and reproducibility. The subsequent use of this test by all the countries in GREP harmonized the interpretation of results and increased confidence in everyone's results. The use of a monoclonal antibody-based test facilitated increased standardization and reproducibility of the test. The high level of specificity (> 99.5 percent) greatly reduced the number of false positive results during the sero-surveillance stage, and saved unwarranted and expensive field investigations resulting from false positive laboratory results.

Rapid diagnosis and detection were essential during the later stages of the eradication programme. The development of a rapid pen-side test (Bruning *et al.,* 1999) proved invaluable in countries such as Pakistan and the United Republic of Tanzania (Wambura *et al.,* 2000), and empowered the field veterinarians to take prompt action to stamp out the last remaining foci of infection.

Technology transfer and technical backstopping: The Rinderpest Laboratory Network, established by the Joint FAO/IAEA Division with the assistance of IAH Pirbright, proved the ideal vehicle for technology transfer. Annual coordination meetings were linked to training courses and updates in diagnostic and serological techniques, software programmes or epidemiological strategies. The cELISA was established in each country, with expert assistance and technical backstopping where needed. The success of this process is highlighted by the fact that the "project holders" are now regarded as experts in their own right and have assisted many other countries in establishing ELISA technology.

Standardized diagnostic reagents: The provision of standardized, quality-controlled reagents played a major part in the eradication programme. Large batches of antigen and control sera were produced, to minimize test variation among laboratories. This was enhanced by the use of a monoclonal antibody-based assay, and a single batch of monoclonal antibody was used for all the competitive ELISA kits produced. The external quality assurance panels supplied by IAH showed 98 percent agreement with the laboratories in Africa, a much higher figure than that reported for human immunodeficiency virus at that time.

Recommendations for further animal health programmes

Although the strategy used for rinderpest eradication is not applicable to all diseases, it could be used as a blueprint for diseases such as PPR. Key factors other than those already mentioned were the availability of an excellent vaccine, secure long-term funding, the establishment of the GREP Secretariat at FAO Headquarters in Rome as a global coordination unit, and evolution of the OIE Pathway to Freedom from Rinderpest, which gave clear guidance to all countries at each stage of the process. The drive and determination of a few key people was also essential to the remarkable success.

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CONTRIBUTIONS OF MOLECULAR VIROLOGY TO RINDERPEST CONTROL

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For many years, the morbillivirus research programme at IAH has contributed, both to our understanding of the biology of rinderpest virus (RPV) (its interactions with its host) and to the diagnosis and epidemiology of the disease. Several elements contributed to the control and eradication programmes. As a recognized centre of diagnostics and research on RPV and PPR virus (PPRV), IAH collected virus isolates from many countries over an extended period. This enabled the comparison of viruses under controlled conditions, and the determination of gene sequences from these different strains. In turn, knowledge of the regions of sequence conservation and diversity in the viral genome enabled the development of effective PCR systems for the direct detection of viral ribonucleic acid (RNA), regardless of strain (geographic origin) (Forsyth and Barrett, 1995). Early systems used gel-based PCR; latterly, the more sensitive real-time PCR was used. These viral sequences also allowed the development of a system of molecular epidemiology, whereby the degree of relatedness of different isolates could be determined and distinct lineages of RPV identified (Chamberlain *et al.,* 1993). This contributed to the knowledge of, and ability to model, the movement and persistence of the virus in the wild (Barrett *et al.,* 1998; Rossiter and James, 1989).

The identification of multiple African lineages was particularly useful in understanding the introduction and spread of the virus in that continent.

Understanding of the basic biology of the virus and the development of reverse-genetics systems for RPV have also been important. They have enabled us to study the variation in phenotype of different virus isolates and the factors that restrict the virus in nature (Nanda *et al.,* 2009; Nanda and Baron, 2006; Baron *et al.,* 2005), as well as to develop improved (differentiation of infected from vaccinated animals [DIVA]) vaccines (Parida *et al.,* 2006; Walsh *et al.,* 2000; Das, Baron and Barrett, 2000). Although these vaccines arrived too late to contribute to the eradication process, they point the way to how we may develop such vaccines for use against PPRV.

The experience acquired during the eradication of rinderpest shows that most of the elements required for the eradication of PPRV exist (e.g., an effective vaccine, sensitive detection systems and molecular epidemiology). Several lessons can be taken from our experience in the RPV eradication programme and may be of use in a programme for the eradication of PPRV or another livestock virus. In addition to the need for a transnational network of cooperating diagnostic laboratories, there is need for rapid, sensitive and accurate diagnostic techniques coupled with identification of the infecting virus lineage/origin; we have already seen examples where this has been very useful in understanding PPRV spread. The appropriateness of technology for local diagnostic laboratories was not always fully understood during the RPV campaign, and this needs to be considered in the future. In many cases, new technologies, such as PCR, were introduced into areas where a suitable infrastructure was not yet in place. It is hoped that arrangements such as the OIE-sponsored twinning of laboratories may help to upgrade local laboratories at all levels, not just in the provision of equipment. Virus monitoring via serum surveillance was hampered during various stages of the eradication of RPV by the lack of a DIVA vaccine. Although the number of PPRV vaccines is increasing, those in current use are attenuated forms of PPRV, and will pose the same problems. It would be of significant benefit if a good DIVA vaccine against PPRV was developed, and we and others are working towards that goal at the moment. Our understanding of the biology of PPRV is limited, particularly regarding the way(s) in which it differs from RPV and the reasons for the species restriction of the two viruses. This is an area for improvement, along with better knowledge of the history and origins of PPRV.

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RINDERPEST LABORATORY CAPACITY BUILDING AND SERO-MONITORING: THE CONTRIBUTION OF THE JOINT FAO/IAEA DIVISION

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Introduction

GREP effectively began in 1986 with the formation of PARC, followed shortly by similar programmes in West Asia (WAREC) and South Asia (SAREC). It was not until the mid-1990s that these came under the more formal coordination of a fully established GREP with the unifying aim of global eradication (IAEA, 1994). Even so, in 1986 the underlying principle was the control and elimination of rinderpest through mass vaccination, to be followed by targeted surveillance and vaccination to remove remaining foci of infection. Importantly, the feasibility of eradication was based on the understanding that rinderpest immunity levels of about 85 percent in a population of cattle would result in elimination of the virus from that population. Thus, from the outset, it was appreciated that it would be necessary to monitor cattle serologically to ensure that levels of immunity of this order were achieved, through either vaccination or natural infection (Rossiter and James, 1989).

Why the Joint FAO/IAEA Division?

The Joint FAO/IAEA Division was established to promote and support the use of nuclear and related technologies for peaceful use in agriculture. This support is provided in two main ways: through IAEA technical cooperation programmes (TCPs) for the transfer of technologies; and through FAO/IAEA coordinated research programmes (CRPs) for undertaking research.

In 1986, following recommendations made by a nine-member consultative group, the Animal Production and Health Section of the Joint FAO/IAEA Division introduced an animal health component to its programme of support to scientists in developing countries. Central to this support was the use of a nuclear-related technology, ELISA, for the diagnosis and control of livestock disease. It had been apparent for some time that ELISA had a great deal to offer the diagnostician in developing countries. The technique is relatively simple to use and of low cost; a large number of samples can be tested in a short time; and the technology can be applied to the detection of both antibodies and the pathogen. This was ideally suited to the needs of PARC, SAREC, WAREC and, ultimately, GREP.

To provide support for this new programme, the Swedish International Development Cooperation Agency (SIDA) agreed to fund a CRP focused on the use of ELISA. While not initially focused on rinderpest, this provided a suitable structure for undertaking the laboratory testing associated with sero-monitoring. Over the next following years, the CRP became the process under which a network of laboratories were maintained across Africa, focused on sero-monitoring and then surveillance for rinderpest (IAEA, 1991b).

The rinderpest laboratory network

The laboratory support component of rinderpest eradication was developed and operationalized through PARC and the SIDA-funded CRP. It soon became apparent that the introduction and use of the ELISA-based system for sero-monitoring in veterinary laboratories in developing countries was a complex and far-from-straightforward task, particularly for generating reliable results that could be compared among laboratories, countries and even regions. It was realized that the system needed to be fully standardized, very robust, quality-assured and adequately supported.

Initially, a standardized ELISA kit was developed and validated at the IAH Pirbright Laboratory in the United Kingdom. Subsequently, every test component was provided in a kit format, even including water for reconstituting freeze-dried reagents (FAO, 1999). All equipment was fully standardized using only one manufacturer, and computer software was written both for operating the ELISA readers and for calculating and storing all results. Although the actual collection of the sera was undertaken by field officers, a standardized sampling frame was agreed from the outset, using a randomized, stratified approach across locations and animal ages (Anderson, McKay and Butcher, 1991). Once operational, it became clear that both laboratory internal quality controls and external proficiency testing were needed to ensure and manage quality assurance, and this became an essential component throughout the network. In total, some 2 million sera have been tested with, at the height of testing, 98 percent agreement using proficiency testing panels (IAEA, 1988; 1991; Jeggo and Anderson, 1991; 1992).

Support

The FAO/IAEA CRP proved an ideal mechanism for supporting national PARC laboratories. Appropriate diagnosticians in each PARC laboratory were awarded research contracts, which provided crucial funding for key laboratory and field activities. Annual research coordination meetings ensured that results were delivered and shared, providing an opportunity not only to inform PARC of progress but also to troubleshoot the programme and deliver specialized training.

Support from IAEA went well beyond that provided through the CRPs. IAEA TCPs, both national and regional, provided extensive additional support. Under an IAEA TCP it is possible to provide a range of laboratory equipment, send in experts, and provide fellowships and training courses tailored to the needs of specific rinderpest laboratory activities. The TCP was of great importance outside Africa. It was not possible to gain external funding for CRPs other than through PARC, so support to WAREC, SAREC and, ultimately, all GREP countries was provided through IAEA TCPs. In total, some 150 TCPs supported the eradication programme, with much being delivered through regional TCPs in Africa, West Asia and South Asia.

Through both the Joint FAO/IAEA Division CRPs and the IAEA TCPs, support has been continually provided over the last 25 years to more than 50 laboratories involved in the eradication process.

Lessons learned

- Effective laboratory support is essential for an eradication programme such as GREP.
- Support to laboratories must be broadly based and include essential equipment and reagents, training, expert assistance and, where required, operational funds. Without funds, the laboratory cannot support disease control/eradication programmes effectively.

- Support for individuals within the laboratory is as essential as the general process. The ability to operate within the framework of a network, with routine meetings and sharing of results, brings immense value and reward for individuals.
- Standardization is the only way to achieve effective comparison of results among laboratories. A harmonized approach, particularly in the developing country setting, is highly unlikely to succeed without it. This process of standardization should be applied across the whole range of laboratory-linked activities and not just to the test itself.
- Quality assurance is an essential component of any laboratory activity. It should be used as a supportive tool for developing and enhancing the network, rather than for identifying poor performance as such.
- While the technology needs within a laboratory are likely to change during an eradication programme, once a network has been established, it is relatively straightforward to validate and implement further technology transfer and use.
- Laboratories must be obliged to prepare and submit results on a routine basis. This ensures not only the effectiveness of the programme but also the continual operation of laboratory activities. Maintaining a functioning laboratory component is a far more cost-effective approach than routine resurrection of such capabilities.

Recommendations for further animal health programmes

Without doubt, FMD is the biggest single disease impediment to trade in livestock and livestock products, to the sustainability of livestock development in poor countries and to overall food security. While current vaccines leave much to be desired, FMD has been eliminated in many countries and regions, and – in the longer term – it is feasible to consider global eradication. While this will take a significant number of years to achieve, progressive control on a global basis has to be a priority for national veterinary services and regional and international organizations.

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A NON-EXHAUSTIVE REVIEW OF THE EUROPEAN UNION'S CONTRIBUTION TO RINDERPEST ERADICATION

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Introduction

The EU has been a major contributor to the control and eradication of rinderpest, being a consistent and major donor over time. The European Commission, in addition to being a leading force in this challenge, has also taken advantage of it to build a solid policy of long-term capacity building in animal health and livestock services.

EU contributions to rinderpest eradication

Since the 1960s, the European Community, and subsequently the EU have contributed to the following major operations on the African continent:

- *JP15 (1961 to 1976):* Support of EUR 5 million from European Development Funds (EDF) was used at the country level to cater for vaccination costs against rinderpest. Another major donor to JP15 was the United States of America, and additional resources were provided by the United Kingdom, Germany and Canada.
- *PARC (1986 to 1998):* The sixth and seventh EDFs contributed EUR 115 million through a series of financing agreements. These initially financed emergency vaccinations, and later linked access to funding (for other than emergency vaccination) to the articulation of policy reforms for national veterinary services. Interventions at the country level were financed by mixing resources from the national and the regional envelopes of EDF, which was perceived as an innovative way of balancing common and national interests (country ownership). Additional resources to PARC were provided by Japan, the United Kingdom, Italy, Belgium and Nigeria.
- *PACE (1999 to 2006):* A single financing agreement with resources from the regional envelope of EDF (EUR 77 million), the United Kingdom, France and Italy. PACE remains one of the largest EU financing agreements in the agriculture/rural development sector. It was designed to link rinderpest interventions in Africa to the OIE Pathway, with a shift towards surveillance and the necessary changes this implied for African veterinary services.

- *Wildlife veterinary projects (2000 to 2003):* In response to concerns expressed by AU-IBAR on the rinderpest serological status of wildlife, EDF provided an additional EUR 2 million to undertake a unique wildlife sampling operation in West, Central and East Africa.
- *SERECU (2007 to 2010):* Taking stock of progress made in the epidemiological surveillance of rinderpest in most of Africa, a EUR 4 million EDF project was approved to focus on surveillance in the Somali ecosystem (Ethiopia, Kenya and Somalia). A recent independent evaluation of the project confirmed that the expected results were achieved – a contribution towards bringing us here today.

Among the world's other regions, Asia has benefited particularly from the European Commission's efforts against rinderpest, through various generations of projects and regional programmes:

- In the late 1970s, the European Commission started its first *livestock development project* in Pakistan, Baluchistan (EUR 7.45 million), with activities that were already taking rinderpest control on board.
- The late 1980s saw the emergence of country-based projects addressing the *strengthening of veterinary services (SVS) for livestock disease control,* with a clear focus on rinderpest control. Actions were implemented in India, Nepal and Bhutan (EUR 53 million).
- The first generation of SVS projects was consolidated in 1996 with a regional operation of EUR 7.7 million, the *South Asia Rinderpest Eradication Campaign,* which however never took off.
- At the request of FAO, an *emergency supply of rinderpest vaccines for Pakistan* was funded and mobilized swiftly in 1995 (EUR 400 000).

Finally, and for both regions, FAO has recently received an additional EU grant of EUR 2.8 million to look forward to a rinderpest-free world.

Throughout this evolution, the European Commission services in charge of development cooperation with Asia invested time and forces in regularly drawing lessons from projects focusing on animal health, particularly rinderpest and other disease control. This allowed better appraisal of new actions and adaptation to the quickly changing and various realities of Asia. These analysis efforts resulted in the emergence of a new generation of SVS projects. At the same time, the European Commission was projecting itself into the future with policy documents on livestock and development:

- From 1996 onwards, Southeast Asia (Viet Nam, Lao People's Democratic Republic and Cambodia) and Bangladesh benefited from the *new generation of SVS projects,* which were appraised almost in parallel and had the same integrated objectives: the long-term reinforcement of animal health systems, and information, coordination and reporting at international standards. Dimensions of regional networking and One Health were already present, although not as explicitly as they were in the twenty-first century. These operations were funded with a total of EUR 16 million.
- A similar operation was launched in *Pakistan* in 2001, for EUR 22.9 million.
- Follow-up projects were funded by the EU in *Lao People's Democratic Republic and Cambodia* (livestock smallholder support) for a total of EUR 8.8 million; in 2009/2010 these had just reached the end of their implementation phase.

In summary, over 40 years, the European Commission has contributed worldwide an amount close to EUR 340 million, while the EU's contribution to rinderpest eradication might well be about EUR 390 million. However, this figure is not intended to dwarf the contributions of non-EU donors (particularly the United States of America, Canada, Japan and Switzerland), and – of course – the participation of beneficiary countries.

Lessons learned

Eradication is a long-term process: Keeping international actors and development partners constantly mobilized against rinderpest has been a challenge over these 40 years. Discouragement was probably avoided thanks to the progressive development of programme design, taking lessons learned into account, encompassing wider development objectives, and adjusting to the evolving paradigms of the international agenda. Europe has been at the forefront of this evolution. For example, reference to the OIE Pathway and OIE's prominent involvement in the governance structure of PACE has supported the argument for considering that this is a trade-related assistance programme, which goes beyond a technical programme. The flexibility to organize interventions in South Sudan during years of civil war is also noticeable.

Long-term capacity building must remain the goal: Through its continual focus on long-term capacity building, such as broad institutional reinforcement, on multisectoral and comprehensive approaches, and on the subregional and regional convergence of standards, the EU has been a driving force towards achieving an internationally shared platform for livestock disease control. Many of the EU-supported actions described previously included rinderpest control, either on its own or as part of a broader integrated package. Another essential feature is that the European Commission has been constantly contributing to shaping the veterinary and public health services of tomorrow and beyond. The natural interactions and necessary cooperation between the animal and human health sectors were addressed early in the process, and became increasingly obvious as animal health projects and programmes became more sophisticated.

It is therefore not surprising that when it decided to co-organize the first International Ministerial Conference on Avian and Pandemic Influenza (IMCAPI) in Beijing in January 2006, the EU promoted, and subsequently funded, actions in response to the avian influenza crisis. These focused on planning, long-term capacity building and a multisectoral integrated approach to pandemic and high-impact sanitary hazards.

Aid effectiveness: Aid effectiveness is a challenge for programmes that cover a wide geographical area and have a long timeframe, such as transboundary disease control. This issue figures highly on the agenda of the international community. The Paris Declaration and the Accra Agenda for Action promote several concepts that are challenging for programmes such as transboundary disease control. Can we retrospectively draw lessons for future programmes from rinderpest control/eradication?

Ownership, measured by the extent to which developing countries set their own strategies for poverty reduction, improve their institutions and address governance, is the first challenge. Although developing countries participate in the definition of an international agenda (GREP for instance), the translation of this agenda into individual countries' development agendas can remain a difficult issue. The extent to which specific policies are financed compounds the difficulties. AU-IBAR's effort to convene ministerial meetings was an attempt to ensure such translation. Improvement of institutions was, however, seldom reflected in country Poverty Reduction Strategy Papers. The combination of EDF national and regional funds during PARC also aimed to ensure ownership at the country level.

Donor countries should *align* behind these objectives and use local systems. In the case of rinderpest control, donors aligned with the international agenda, represented by GREP and the OIE Pathway, much more than with explicit national agendas. While project implementation modalities have remained a central feature of cooperation in animal health issues, the option of a sector approach might offer interesting advantages for ensuring the continuous delivery of veterinary public goods.

Harmonization is assessed by countries' capacity to coordinate, simplify procedures and share information to avoid duplication. Coordination among donors has been an important feature of AU-IBAR-led programmes, with a particular reference to the PARC technical committees and the PACE Policy Committee. This was backed-up by effective EU coordination, allowing continuous support and sharing of burdens. EDF funding generated a dynamic that involved Member States alongside the European Commission. This was particularly the case of the United Kingdom, France, Italy and Belgium, which used a variety of modalities: parallel funding of jointly approved activities; co-funding of technical assistance; and delegated management of resources from one donor to another.

Conclusion

The world is about to declare freedom from rinderpest, and the donor community is proud to see the results achieved and the impact of its contribution. Over 40 years, in pursuing this worldwide objective, the European Commission has contributed close to EUR 340 million, a very significant amount. Rinderpest control has united many organizations – donor, regulatory, scientific and administrative – behind one goal, and this may have been a key to success, while promoting structural changes in a concomitant manner. Regional organizations benefited, as well as national ones, and the institutional build-up of AU-IBAR and PANVAC during these years is now crucial to AUC.

The international consensus achieved within just three years on the need for prevention of and response to the serious risks at the interface among animals, humans and their various environments (the One Health approach) is also a natural and logical development of the policy evolution that started with rinderpest control.

In the aftermath of the Alma Ata Declaration on Primary Health Care (September 1978), debate started on the need to "horizontalize" all cooperation actions in the field of health. EU-funded projects and programmes of the last generation integrate almost naturally the vertical and horizontal dimensions of disease control and health improvement. Through the success of the global response to avian influenza, the comprehensiveness of modern cooperation in health can be seen as the very positive outcome of 30 years of considerable effort by development partners at the national, regional and international levels.

In various fora, and recently at IMCAPI Hanoi 2010, the EU has reiterated its commitment to continuing to play a role as policy developer and major actor in global health.

GLOBAL ECONOMIC BENEFITS OF RINDERPEST ERADICATION: TECHNICAL ISSUES AND PERSPECTIVES

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Animal diseases generate numerous economic impacts, both in terms of their control costs, and through the disruptions that such diseases cause on domestic and international commerce in the livestock sector, in related downstream industries (e.g., processing, distribution, retail) and in unrelated sectors such as services or tourism. Livelihood impacts are also important in the developing world, where livestock serve important non-commercial roles, and are for many households an important pathway out of poverty (Rich and Perry, 2010).

Rinderpest was once responsible for a variety of socio-economic dislocations, particularly in Africa, Asia and the Near East. While much has been documented on the epidemiological, technical and institutional lessons resulting from its eradication, very little has been written on what this means for society at a global level. Normile (2008) cites FAO estimates of control costs of USD 610 million, and potential annual benefits for Africa alone of USD 1 billion. Using FAO estimates, Catley, Leyland and Bishop (2005) calculate that the benefits of rinderpest control on livestock production in India between 1965 to 1998 were USD 289 billion, while the benefits for Africa during the same period were USD 47 billion. Roeder and Rich (2009) remark that many of the findings on the economic impact of rinderpest are case-specific and Africa-focused. The most widely cited study in Africa was conducted by Tambi *et al.* (1999) in the context of PARC. Their study conducted a cost-benefit analysis of a subset of ten of the 27 PARC countries (Benin, Burkina Faso, Côte d'Ivoire, Ethiopia, Ghana, Kenya, Mali, Senegal, the United Republic of Tanzania and Uganda), finding average benefit-cost ratios for PARC of 1.85, ranging from 1.06 in Côte d'Ivoire to 3.84 in the United Republic of Tanzania. Very little if any information is available on the socio-economic impacts of rinderpest in non-African contexts, particularly in South Asia, China and the Near East.

At the same time, the figures that do exist often lack thorough discussion of their derivation. There has been no standardization of the methodologies applied or cited, nor have many of the impacts on international trade, downstream sectors or unrelated sectors been captured. We also lack details on the more nuanced impacts on behaviour and the environment, and the potential unintended consequences resulting from rinderpest eradication. Some of these behavioural considerations have been identified by Felton and Ellis (1978), who noted the potential for changes in the cohort structure for animal herds (e.g., fewer and older female cows) due to the diminished risk of rinderpest. Such changes could have important second-round impacts on productivity, efficiency and the marketing of meat products, which have not been adequately costed. Nor have the environmental costs related to the pressures that larger numbers of livestock might have on the carrying capacity of pasturelands now free of rinderpest been thoroughly assessed. In short, we need tools and metrics for analysis that captures more broadly not only the first-round impacts on animal production, but also the second- and third-round effects on other sectors and behaviour that were generated by eradication.

Appropriate tools exist for developing these broader frameworks for analysis. For instance, Roeder and Rich (2009) used social accounting matrices in a recent analysis of rinderpest to look at the macro impacts associated with rinderpest control. They found that the livestock sectors of East Africa had relatively high activity multipliers (between 3 and 5, meaning that a USD 1 increase in final demand would increase the economy-wide output by USD 3 to 5) compared with those in other sectors, suggesting that government spending in the sector (such as investments in rinderpest campaigns) would be broadly beneficial. Such methods, combined with more extensive benefit-cost analyses that trace production and behavioural patterns before control campaigns began, would serve to improve calibration of the scope of rinderpest eradication at a national level, and could be employed in global models (e.g., the Global Trade Analysis Project) to determine the global benefits for disease control.

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SOCIO-ECONOMIC IMPACTS OF RINDERPEST ERADICATION

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Introduction

Limited studies have attempted to put an economic value on the cost of rinderpest or the cost and benefits of its control. The losses from rinderpest in Nigeria in the 1980s have been estimated at USD 2 billion, and FAO estimates the total costs of control at USD 610 million, including USD 289 billion (for India) and USD 47 billion (for Africa) between 1965 and 1998. However, we do not have a systematic and comprehensive global assessment, and the available estimates seldom provide information on the return on investment, a key parameter for evaluating past or guiding future investment decisions/choices about the allocation of scarce resources among competing alternatives. Concerning rinderpest, these choices might include:

- fatalistically accepting rinderpest and living with the disease;
- implementing a combination of control measures, but accepting open-ended, recurrent disease and control costs;
- aiming for eradication.

This paper provides an initial, admittedly crude, attempt to quantify the costs and benefits of rinderpest eradication versus controlling, but "living with", the disease, as was the case prior to concerted eradication programmes. In this preliminary assessment we attempt to quantify first- and second-round benefits of rinderpest eradication; at this stage, we have not attempted to capture possible third-round benefits, livelihood impacts or negative externalities of rinderpest eradication. First-round benefits encompass avoided disease losses and control costs (mainly vaccination), while second-round benefits accrue through multiplier effects along the cattle value chain, i.e., economic activities feeding into and from primary cattle production (these may extend into export markets). Third-round effects could, for example, arise from changing production practices and/or herd structures in response to elimination of the rinderpest risk. Rinderpest led to non-linear livelihood impacts when pastoral herd size was reduced below the critical threshold required to ensure household survival, while negative externalities might arise from increased grazing pressure due to herd growth.

Methodology

There is a shortage of data from more recent rinderpest eradication programmes, but Felton and Ellis (1978) and MacFarlane (1976) provide figures from JP15 relating to the numbers of vaccinations carried out and the numbers of outbreaks of rinderpest occurring annually, in Nigeria and in Kenya respectively. Both data sets show what appears to be a very clear correlation between the increased number of vaccinations carried out in each country under the JP15 campaign and a simultaneous decrease in the number of reported outbreaks of rinderpest, to the point of eradication. JP15 eradicated rinderpest in Nigeria by 1963 and in Kenya by 1967, at which point it should have been possible to reduce the overall costs of control by stopping rinderpest vaccination and concentrating on disease surveillance and emergency prevention. Unfortunately, this was not possible because the disease was not eradicated in all neighbouring countries, so lower levels of vaccination had to be continued, and even then rinderpest outbreaks occurred in both countries in the early 1980s.

In response to JP15's inability fully to rid Africa of rinderpest, PARC was initiated in 1986 and lasted until 1998. In the decade from 1985 to 1996, national PARC programmes in 14 countries administered more than 255 million doses of rinderpest vaccine to cattle – a huge achievement.

Based on information provided by Felton and Ellis (1978) on pre-JP15 vaccination coverage, incidence of rinderpest outbreaks and average mortality associated with these outbreaks in three neighbouring West African countries (the Niger, Nigeria and Chad), and applying costs of USD 50 for a dead bovine and USD 0.5 per vaccination, it is possible to estimate what would have been the cumulative costs (vaccination and deaths) of "business-as-usual" control campaigns in these countries between 1986 and 2000 and to compare these with the real costs reported for the burst of extra activities under PARC during the same period. We used the household multiplier for cattle in Nigeria (2.48) from the Global Trade Analysis Project database to obtain an initial estimate of the second-round benefits of reduced cattle mortality.

Results

Figures 1a and 1b show that although the costs of PARC were initially higher than the business-as-usual alternative, by 2000, the cumulative costs of PARC were no higher than those of a control approach based on vaccination campaigns that were not aiming to eradicate rinderpest. Without eradication, the cumulative recurrent costs would then outstrip the costs for eradication. These are saved costs are what we refer to as "first-round effects".

Previous studies of benefit-cost ratios for rinderpest control based on only first-round effects derived ratios of 1.06 to 3.84 for PACE (Tambi *et al.*, 1999), 2.48 for JP15 in Nigeria (Felton and Ellis, 1978) and 3.4 for South Sudan (Blakeway, 1995).

Second-round benefits include the added value that will accrue from keeping alive the cattle that would otherwise have died from rinderpest (we acknowledge that some animals might die from other diseases). As mentioned earlier, this value addition occurs at all stages of the production cycle, from breeding and feeding to distribution, processing and retail. In West Africa the household multipliers of cattle are very high compared with those of crops, for example, reflecting the importance of cattle in West African drylands and their contribution to wider economic activities that support the livelihoods of traders, butchers, slaughterhouse employees, transporters, etc. Taking the cattle household multiplier of 2.48 estimated for the Nigerian economy (the largest of the three included in this assessment), and applying it to the average value of a bovine dying from rinderpest (USD 50), each death leads to a total loss of USD 124 through revenue forgone along the value chain. Extrapolat-

FIGURE 1A
Cumulative costs under business as usual

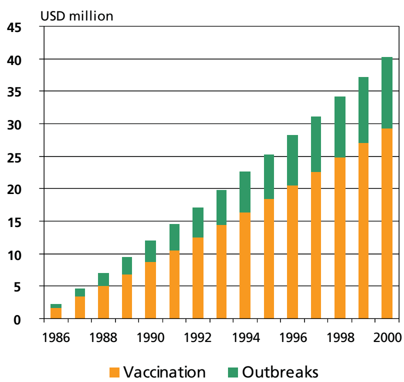


FIGURE 1B
Cumulative costs under PARC

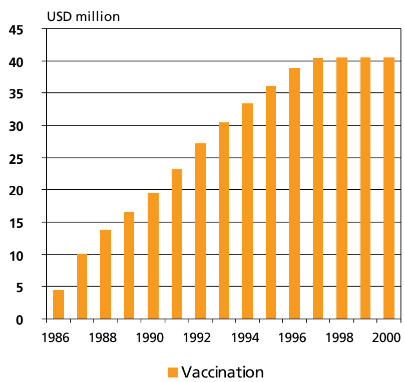


FIGURE 2A
Cumulative costs and benefits of PARC

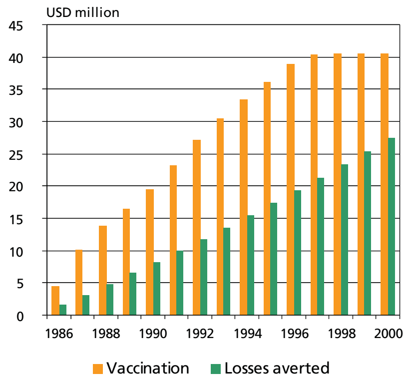
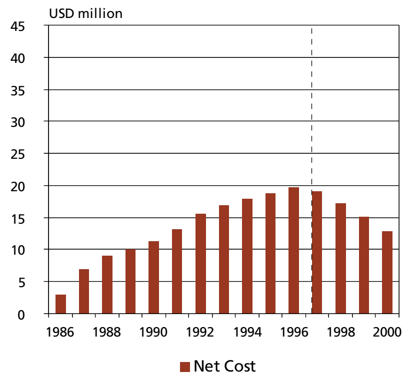


FIGURE 2B
Net costs of PARC



ing further, and applying this to the PARC data for our group of West African countries, we see that by 1997, when vaccination stopped, the cumulative value of losses averted already amounted to about half of the total vaccination cost. Any losses averted after 1997 are net benefits of the eradication effort, and thus reduce the total cost of eradication.

The highest net costs (total vaccination costs minus averted costs) during PARC were some USD 20 million in 1996, after which net costs declined. Comparing this with the business-as-usual scenario for the three West African countries, we see that its cumulative costs would have reached the USD 20 million mark in 1993. This means that only eight years of business as usual in the Niger, Nigeria and Chad would have occasioned disease costs similar to those of the eradication push.

The results are of course based on very generic valuations of cattle and vaccination costs and do not discount these values over time; but they can be considered conservative estimates of eradication benefits, as they consider only mortality and disregard losses that result from morbidity and ensuing stunting and lower reproductive performance. Thus, even allowing for some margin of error, it appears that for the group of countries analysed, investing in the final push was very worthwhile.

Conclusion

We acknowledge that our assessment does not consider spatial patterns, distributional issues, livelihood impacts (etc.) or adaptive behaviour change due to changing risk profiles (third-round effects) and that we are still far from a systematic, comprehensive, global assessment of the costs and benefits of rinderpest eradication. However, there can be little doubt that the investment in rinderpest eradication outperformed most alternatives in disease control.

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Discussion

Dr Rweyemamu recognized the role played by Dr Kris Wojiechowski who convened the consultation on global eradication of rinderpest at FAO in 1992 that gave rise to GREP. The background paper to that meeting, prepared by Drs Gordon Scott and Alain Provost, originally advocated a global rinderpest eradication *campaign*, implying a level of central global command similar to that applied for smallpox eradication. This was discussed in some detail at the meeting, but it was agreed that instead a global rinderpest eradication *programme* might be more appropriate in terms of cost and in promoting a sense of regional and national ownership for rinderpest eradication. This had clearly worked, and it would be interesting to know whether this approach through a globally coordinated programme of regional campaigns was more cost-effective than a single centrally implemented campaign. To assess this, it will be necessary to measure the costs of eradicating rinderpest in comparison with those of eradicating smallpox. This should be looked at in a future history of the eradication process.

A feature of GREP was the annual meetings of technical experts, which allowed continual adjustment or steering of the programme as it progressed. Dr Rweyemamu considered this one of the lessons learned in that it formed an effective "community of practice" for the rinderpest eradication programme. With hindsight, it might have been even more valuable to have included meetings with sociologists and economists. This might have left meeting participants better placed to answer many of the questions they now face about the real gains of the eradication of rinderpest.

Dr Domenech suggested that the meeting had been lucky to be able to analyse the socio-economic impact of rinderpest retrospectively – and to get such a positive result.

Drs Unger and Otte suggested that the accounting that will be needed to assess PPR programmes should start immediately.

Dr Mariner recommended collecting data on the full impact of PPR, and not just the economic aspects.

Dr de Haan reminded the meeting that a broader-based livelihood study in northern Kenya had found that – without doubt – PPR pushed many owners out of livestock production. This in turn could have knock-on effects, as these people may move on to income-generating activities such as charcoal production, with consequent negative effects on the environment.

Dr Otte agreed that such analysis needs to be carried out for both pastoralists and farmers dependent on draught power.

Responding to *Dr Nawathe, Dr Otte* reported that it was difficult to say whether or not the epidemic in Nigeria had affected the growth of the livestock population. Sometimes in this type of analysis changes could be seen, but cause and effect were difficult to assess when so many other factors were in play.

Dr Wilsmore commented that economic losses included not only the animals that died but also the lost production from survivors.

Dr Otte suggested that more information was needed before these production losses could be analysed accurately. In the meantime, it was clear that they were not negligible.

Regional experience

Chaired by Dr Peter L. Roeder

RINDERPEST ERADICATION FROM AFRICA: LESSONS LEARNED

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Introduction and main tasks during rinderpest eradication

AU-IBAR was established in 1951 with the responsibility for eliminating rinderpest from Egypt and sub-Saharan Africa, where continual east-west cattle movements prevented effective control by individual countries. The need for a concerted effort for rinderpest eradication was recognized, and in 1961 the heads of veterinary services in Africa launched a multi-nation joint project (JP15) coordinated by the Organization of African Unity (OAU). JP15 aimed to vaccinate all cattle of all ages every year for three successive years, using live attenuated vaccines to confer durable immunity. JP15 was implemented from 1962 to 1979 in 22 countries in West, Central and East Africa, at an estimated cost of USD 16.4 million, co-funded by national governments, EDF, USAID and the Governments of the United Kingdom, Germany and Canada.

By the end of JP15, rinderpest had been eliminated from most of the participating countries, except for a few sporadic outbreaks on the Mauritania-Mali border in West Africa and in Ethiopia and South Sudan in East Africa. The success was short-lived, however, and a few years later, rinderpest epidemics recurred in more than half of the countries, prompting African heads of State and government to recommend a fresh pan-Africa rinderpest eradication campaign in 1981. PARC was established under the coordination of OAU-IBAR as a continent-wide campaign to eradicate rinderpest from Africa. PARC was implemented in 26 countries between 1986 and 1998, at a total cost of 110.18 million European currency units, provided mainly by the EU supplemented by bilateral donors such as the United Kingdom, Italy, France, Nigeria and Japan.

PARC's main activities included mass vaccination, disease surveillance, the restructuring of veterinary services, and the prevention of desertification in member countries. 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 by increased surveillance and targeted vaccination around outbreaks. After 12 years of PARC, most sub-Saharan African countries were free from rinderpest, and many had joined the OIE Pathway by declaring provisional freedom from rinderpest. However, two small foci persisted, in the Sudan and war-torn Somalia.

The evaluation of PARC in 1996 recommended its continuation, to consolidate the gains made and facilitate the eradication of rinderpest from the remaining foci. Consequently, the EU provided EUR 90 million for the implementation of PACE from 2000 to 2007. PACE established epidemio-surveillance and laboratory networks and developed disease data management and diagnostic skills across Africa. PACE also facilitated the control of other major epizootic diseases in Africa. At the end of PACE, 27 of the participating countries had made significant progress along the OIE Pathway for the eradication of rinderpest. Of these, 16 had been recognized as free from rinderpest.

Despite these successes, there were concerns that residual foci of rinderpest may have remained in the Somali ecosystem comprising south-eastern Ethiopia, north-eastern Kenya and Somalia. This was the last area where rinderpest was diagnosed, in 2001.

To address these concerns, SERECU was established to ensure that the three Somali ecosystem countries would attain international recognition of rinderpest freedom through an epidemiologically driven strategy. The first phase of SERECU was funded within PACE from January 2006 to February 2007. FAO-GREP and AU-IBAR supported a bridging phase between March 2007 and April 2008, and the second phase was funded by the EU and implemented from May 2008 to December 2010. Ethiopia, Kenya and Somalia were accredited free from rinderpest in 2008, 2009 and 2010 respectively.

Lessons learned concerning eradication

- Rinderpest eradication programmes required sustained political goodwill to support technical interventions in an environment of peace and security.
- Sustained funding by donors was vital to the success of the eradication process.
- Rational and strategic vaccination (immunosterilization) based on rigorous epidemiological surveillance not only reduced wastage of scarce public funds but also sped up the process of disease eradication.
- Mild strains of rinderpest had to be understood and dealt with to ensure total elimination of the disease.
- Innovative approaches to the delivery of animal health services – including the use of community animal health workers (CAHWs) and participatory epidemiology techniques – facilitated access and elimination of the disease from remote areas affected by political instability, civil strife and insecurity.
- Sustained funding for effective disease reporting/early warning systems incorporating all stakeholders was necessary to ensure early detection and rapid stamping out of any future incursion of rinderpest.
- The ecosystem approach, with enhanced coordination and harmonization among the veterinary services of neighbouring countries, proved critical for the final eradication of rinderpest.

Recommendations for future animal health programmes

- Although rinderpest is now eradicated from Africa, other TADs continue to erode Africa's access to lucrative livestock export markets. Strategies for the progressive control of these diseases and continued vigilance for rinderpest re-emergence are needed.
- There is need to establish an effective syndromic surveillance system for TADs, linking key stakeholders for the exchange of disease information and for expeditious emergency responses.

- All the rinderpest virus strains held in laboratories in Africa should be destroyed or kept in high-biosecurity facilities to reduce the chances of virus escape.
- While maintaining and strengthening partnerships with development partners, African countries need to develop more innovative ways of sustainably funding animal health services.
- A specific programme should be formulated for the progressive control of PPR and other trade-sensitive diseases.
- The AU should continue its coordination and advocacy roles in lobbying governments and the donor community to commit more financial resources to the development of animal resources in Africa.

RINDERPEST ERADICATION FROM THE NEAR EAST: LESSONS LEARNED

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Introduction

I would like to present some lessons that I have learned about the eradication of rinderpest from my experience in a number of capacities, including:

- membership of the OIE ad-hoc group for recognition of the rinderpest freedom status of member countries;
- managing the FAO Animal Health Regional Centre for the Near East region;
- supporting and inviting countries in the Near East region (20 countries) to start official procedures for recognition of rinderpest-free status; in 2007 only one country was recognized as officially free from rinderpest (Egypt);
- preparation of the first dossier for recognition of rinderpest-free status in the Near East region (Egypt 2003), and supporting FAO in preparing three other dossiers for countries in the Near East;
- membership of the OIE Scientific Committee for Control of Animal Diseases.

Lessons learned from the eradication

Successful eradiation in the Near East region depended on:

- backstopping projects in the Near East and Africa:
  - PARC and PACE played important roles, not only in the eradication of rinderpest but also as important elements for strengthening animal health capability at the national and regional levels;
  - FAO provided technical and financial support to assist countries in achieving positive results over the last few years;
- awareness building in the countries concerned on the programme's importance and advantages (beyond its effects on exports);
- clarification of the procedures necessary for official recognition of disease-free status (dossier preparation);
- confirmation of the confidentiality of the information in the dossier, the request presented and the decision taken by the committee (if rejected).

In some regions it was important to nominate a liaison expert from the region, to support targeted countries technically and logistically, as well as to follow the progress of the programme in each country.

OIE's annual ceremonies for presenting official certificates of recognition of rinderpest-free status to the CVOs of successful countries encouraged other countries in the same region to follow the example.

Recommendation for further animal health programmes

PPR and FMD are the diseases proposed to be addressed after rinderpest, following appropriate discussion and assessment.

SERO-MONITORING OF RINDERPEST IN AFRICA

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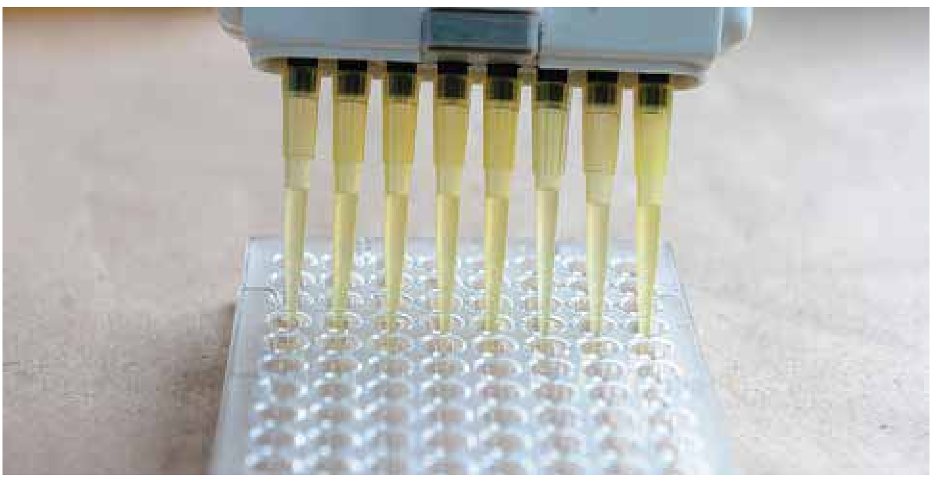
Sero-monitoring to verify the success of rinderpest vaccination programmes was implemented by participating African countries within the framework of PARC. In this connection, in 1986, the Joint FAO/IAEA Division established a designated co-coordinated research programme funded by SIDA to support national laboratories in Africa in meeting the requirements of the sero-monitoring. During the programme, 21 research contracts were awarded to scientists representing African countries, for the purchase of basic ELISA equipment, ELISA kits and ELISA plates. Research agreements were also awarded to two scientists from the World Reference Laboratories for Rinderpest and PPR to provide technical guidance. To support the programme, IAEA operated a TCP aimed at providing support (equipment, training and expert services) to its Member States for the peaceful use of nuclear and related techniques. The main components of the programme, which was



2 July 2010, Polgolla - A batch of fluid samples being processed for testing at the Animal Virus Laboratory. FAO Project TCP/INT/3204 - Surveillance for accreditation of freedom from Rinderpest. To assist selected countries to obtain rinderpest infection-free status: Inter Regional Kazakhstan, Liberia, Sri Lanka.

in four phases, were research coordination meetings; training and provision of FAO/IAEA rinderpest ELISA kits; quality assurance; and computerization and epidemiological support. Overall coordination of activities was carried out by the FAO/IAEA Regional Technical Cooperation Expert for Animal Production and Health.

LESSONS LEARNED FROM THE ERADICATION OF RINDERPEST WITH EMPHASIS ON COORDINATION, PARTNERSHIP AND COLLABORATION IN SUB-SAHARAN AFRICA

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Introduction

With the support of donor communities and international organizations, JP15, PARC, PACE, the Community-Based Animal Health Participatory and Epidemiology Project and, more recently, SERECU accomplished a major part of the programme towards the objective of FAO-GREP. This paper presents lessons learned and personal experiences summarized under main topics such as: issues related to coordination, partnership, control strategies, resource mobilization, institutional performance, and improved delivery of animal health services. As far as possible, veterinary policies must include the private sector, livestock owners and other stakeholders as major players.

Lessons learned from the eradication of rinderpest in sub-Saharan Africa

Coordination and partnerships were the keys to success: The rinderpest experience has shown that where collaboration has been most effective, there has been a clearly and efficiently articulated control and eradication strategy. *At the international level,* the high level of collaboration and synergy among AU-IBAR, OIE, FAO, the EU, DFID and other bilateral and international donors demonstrated their flexibility in developing new mechanisms for responding to rinderpest eradication. *At the regional level,* under the umbrella of FAO and OIE, the Framework for the Global Plan of Action against TADs was established, and significant progress has been made in engaging regional organizations such as AU-IBAR.

Resource mobilization in sub-Saharan Africa: A good example of sustained support has been the regional cooperation among agencies, AU-IBAR and donors: the EU, DFID, USAID, Member States, the French Ministry of Foreign Affairs, and a wide range of NGOs. These institutions committed to eradicating rinderpest and preventing and controlling other epizootics in sub-Saharan Africa.

The main lesson learned is that a regional approach based on efficient surveillance, effective international collaboration, a well-designed national strategy and sustained donor and country support is of central importance. The following were other major lessons:

- Effective collaboration and the development of international, national and regional capacity in surveillance are vital. Increased investment in surveillance capacity, early detection and rapid response mechanisms and donor collaboration were cost-effective.
- The country focus and ecosystem approach to rinderpest eradication during SERECU were critical to its success and to improving the coordination of donor support and

avoiding the duplication of effort. Emphasis on the country level also contributed significantly to the development of essential capacity and verification of the circulation of mild rinderpest.

Recommendations for future animal health programmes

Focusing on the public good of TAD control: This focus helped address rinderpest and can be applied to a number of other diseases that are transboundary in nature. Control and prevention of such diseases is an international public good, and therefore requires long-term investment from governments, donors and the private and public sectors. Priority diseases that should be prevented and controlled include CBPP, PPR, RVF, FMD, African swine fever, tuberculosis, brucellosis, rabies and food- and water-borne infections. All these require significant investment to prevent their further spread and reduce their negative impacts, and the systems established during rinderpest eradication should be utilized for this.

Stronger economic assessment: The economic aspects of disease control need to be given more attention and to be incorporated into assessments of what was done during rinderpest eradication and into future possible programmes. Cost-benefit analyses, costing of different strategies and socio-economic assessment will quantify the burden of rinderpest over the past 30 years and help to prioritize future actions and interventions. The results should support the case for investing in the livestock sector. The economic analysis modules developed under PARC should be improved and transferred to all the countries in sub-Saharan Africa.

Establishment of epidemiology and wildlife units: Capacity for monitoring wildlife disease and undertaking sero-surveys (particularly in relation to rinderpest) has been developed. There is need to establish a wildlife disease association for Africa, to improve wildlife health capacity (capture, sampling, diagnostics, natural history, ecology, etc.) among professionals in ministries of agriculture, environment, forestry and health.

Strengthened institutional capacity at the AU-IBAR and country levels: As a technical body specialized in animal health and production, AU-IBAR requires a solid pool of recognized African experts to respond to demands from Member States. Capacity building was assisted by the provision of technical assistance and by close partnerships with other bodies and international organizations. This helped to accelerate the process of demonstrating rinderpest freedom from the Somali ecosystem, with the assistance of countries involved, OIE, FAO and other technical and financial partners.

Participatory disease searching as a special application of participatory epidemiology method: This was developed and successfully used for the detection of mild rinderpest in the Somali ecosystem. It should be perpetrated through effective capacity building involving non-technical as well as technical competencies.

Remaining challenges: In most sub-Saharan African countries, a number of institutional and administrative problems still exist, compounded by a lack of political and financial commitment to addressing TAD problems. Finding the solution to these constraints remains one of the main challenges to improving animal health in sub-Saharan Africa.

Recommendation

Addressing issues of public good related to animal health requires a long-term vision. Institutional coordination is therefore needed, and strategic collaboration and partnerships must be promoted among international organizations, especially FAO and OIE.

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LESSONS AND GUIDELINES FOR DISEASE ERADICATION

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Lessons learned

These lessons, recommendations and guidelines are influenced by experience of working on rinderpest control, starting with the JP15 mass vaccination campaign.

An important lesson from JP15 was that three years of blanket vaccination with no regard for the epidemiological significance of cattle numbers, distributions, movements and husbandry was not an appropriate strategy. Another lesson was that there must be communication with cattle keepers to convince them of the need for vaccination and counter other considerations that could argue against them having their animals vaccinated.

As a result of not taking these and other considerations into account, JP15 controlled rinderpest but did not eradicate it, and the disease returned as a major epidemic in Africa. This prompted establishment of PARC and PACE, which also initially relied on blanket vaccination. However, for the reasons described previously, sufficient levels of population immunity were not being achieved to attain eradication. Indeed, it was proposed that sub-optimal vaccination could mask the presence of disease and decrease the efficacy of surveillance programmes, and could be worse than no vaccination (Mariner *et al.,* 2005).

Another lesson was that discrete time-bound projects have not been the best approach to the control and eradication of a major transboundary disease. While JP15 was highly successful in introducing regional control, and reduced prevalence almost to eradication, failure to continue surveillance and control activities after the end of the project allowed the resurgence of rinderpest in Africa.

Since JP15, a variety of tools, methods and collaborations have been developed through efforts to control rinderpest and, more recently, highly pathogenic avian influenza (HPAI), which can be applied to the control of other existing and new transboundary diseases. These include:

- an OIE Pathway, in which cessation of vaccination is a prerequisite for verification of viral eradication (OIE, 1999) and through which random sample sero-surveillance is introduced;
- epidemiological analysis leading to targeted surveillance, including the use of participatory techniques;
- new laboratory diagnostic techniques and improved laboratory capacities;
- field diagnostics, such as pen-side tests;
- national, regional and international networks for sharing disease information;
- risk assessment, contingency planning and (through HPAI control) integrated national action plans for outbreak preparedness;
- for HPAI, maintaining the joint animal and human health rapid response teams that have been trained, for control of other zoonoses;
- disease control simulation exercises to improve outbreak response capability;
- vaccine development, e.g., oral vaccines for wildlife such as against rabies and classical swine fever;
- collaboration among UN agencies, OIE and development partners, enabling better response to disease emergencies;
- economic and socio-economic assessments of the impact and control of animal diseases;
- communication strategies regarding the control of animal and human disease (to promote behaviour change);
- identification of risk points in value chains so interventions can be implemented to minimize disease risks;
- the concept of commodity-based trading, which can create incentives for controlling transboundary disease;
- research networks on disease in livestock and wildlife;
- the OIE Terrestrial Code and the World Health Organization's (WHO's) new International Health Regulations, for better notification of outbreaks and sharing of epidemiological information;
- OIE performance of missions to assess national veterinary services and identify gaps in their capacities that need addressing;
- global early warning system for major animal diseases, combining and coordinating the alert mechanisms of WHO, FAO and OIE.

Guidelines for future disease control and eradication

With lessons learned and the availability of modern methods and tools, new guidelines for transboundary disease control can be considered. Most of these diseases find refuge in developing countries, where there is often a lack of financial and physical resources for their control; transboundary disease control competes with other priorities such as education, health and military activities. Developed countries often have the most to benefit from control of transboundary diseases, particularly FMD, which can spread unpredictably over great distances, because in the country from which it emanates there may not be a developed livestock industry and the disease may have little economic impact. For these reasons, it is vital that regional animal disease control programmes continue to have the support of development partners. If implemented as time-bound projects, they should overlap, to maintain momentum and avoid losing disease control gains that have been achieved between projects.

It could help motivation and prioritization in developing countries if future programmes move from the control of a single disease to a broader remit. The control of livestock diseases that affect trade, including livestock exports, may encourage developing countries' participation. Mechanisms need to be found for *sustained* support for surveillance, diagnosis and response to trade-related diseases and emerging infectious diseases, including zoonoses.

Internationally, there is a move to join animal and public health in a One Health approach to emerging and re-emerging zoonoses. This requires a comprehensive and integrated approach to health risks and diseases at the animal-human-environment interface; this is now being translated into strategies and policies by UN agencies, the World Bank, OIE and other development partners. As part of a One Health approach, regional programmes of syndromic surveillance for trade-restricting diseases and zoonoses, coupled with control programmes and emergency preparedness are advocated. Surveillance of a stomatitis-enteritis syndrome for rinderpest-like conditions, which include the trade-restricting diseases PPR and FMD, would maintain awareness of rinderpest in the unlikely but devastating event of it returning. Other syndromes could be a pneumonia syndrome to capture the trade-restricting pleuropneumonia, and an abortion syndrome to capture the trade-restricting and zoonotic diseases brucellosis and RVF. Other syndromes for surveillance would depend on regional requirements.

Surveillance and control programmes could be undertaken, with development partners' support, through regional organizations. More than 70 percent of emerging infectious diseases, including zoonoses, emanate from wildlife, so components for monitoring wildlife populations should be included.

Programmes should upgrade surveillance, investigation, sampling and diagnostic protocols; introduce risk analysis; map livestock movements (pastoral and value chains); and follow up with relevant disease control activities.

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WILDLIFE AND RINDERPEST

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Introduction

From early research, RPV was known to infect a wide variety of wild hoofed mammals (Plowright, 1963), causing a very similar disease to cattle plague in buffalo and a variety of symptoms in other species (Rossiter, 2000). Despite this, it was felt that wildlife played a minor role in the persistence of the virus; this was an important tenet of control methodology when vaccines had been developed for cattle and become vital to a successful eradication campaign. Frustratingly, at the end of PARC in the 1990s, RPV still persisted, with a large outbreak in wildlife in Tsavo National Park in Kenya reported between 1994 and 1996 (Barrett *et al.,* 1998; Kock *et al.,* 1999b). Mild disease in cattle, and both avirulent and virulent infections were detected in wildlife in eastern Africa. The circulating virus strain caused 60 percent mortality of buffaloes in the national park and spread widely across the southern half of Kenya, finally burning out in Nairobi National Park within a few kilometres of the office responsible for eradication in Africa. There were significant losses of other susceptible species.

Lessons learned

Given the apparent persistence of RPV and its re-emergence in wildlife, a multidisciplinary approach was adopted, integrating wildlife and livestock agency activities and establishing wildlife capacity in AU-IBAR in 1998. Work focused on improving knowledge of the pathology and epidemiology of RPV in wildlife. Wildlife were formally included in surveillance and monitoring programmes along the OIE Pathway to confirm the absence of both disease and infection in a given country. They proved an excellent sentinel and way of tracking historical and current virus circulation, thereby delineating zones of virus persistence (Couacy-Hymann *et al.,* 2005; Rossiter, Wamwayi and Ndungu, 2006; Kock, 2006; 2008; Kock *et al.,* 2006).

Wildlife veterinarians and ecologists brought new skills to the veterinary armoury against rinderpest – the ability to detect disease in free-ranging conditions through monitoring and observation of wildlife and their behaviour. This work brought an appreciation of significant differences in pathology and symptomatology (Kock *et al.,* 1999a) and a wider perspective on the disease ecology, while improving capacity in Africa for catching and sampling susceptible species and populations for wildlife disease research.

By including wildlife studies and surveillance in an apparently failing strategy, GREP was able to succeed in its goal despite initial setbacks. Wildlife were shown not to be RPV maintenance hosts at prevailing population levels, but instead to act as spill-over hosts from cryptic RPV-infected livestock populations. Buffaloes were shown to be amplifiers and vectors (to cattle and other wildlife) of RPV across entire ecosystems, and sensitive indicators of RPV (and mild-strain RPV) and PPRV circulation. They and other species provided a useful sero-surveillance tool for exploring the historical/current circulation of RPV and PPRV. It was not possible to use livestock for this purpose, owing to the inability to use serological methods to differentiate vaccine antibody from antibody developed during natural infection.

For GREP, the most important result of this work was the refocusing of vaccination campaigns on the infected zones of East Africa. Wildlife provided evidence of the decline and then absence of antibody from free-ranging populations, suggesting the eradication of RPV from East, Central and West Africa.

The main lesson learned was the value of following an integrated approach, including multidisciplinary teams and different agencies in studies and surveillance of multi-host infections. This has recently become known as the One Health approach. The benefits of this work to the rinderpest eradication process are now well accepted: it was critical to the final stage of eradication. Further to this, data obtained on PPR spreading, apparently silently, among Uganda buffaloes in 2003/2004 were prescient of the subsequent epidemics in Kenya and the United Republic of Tanzania in 2006 to 2010, but this information was ignored at the time. To make better use of wildlife disease data there is need to consolidate the approach within wildlife and veterinary services globally, including appropriate capacity, training, policy and legislation.

Recommendations

- Multidisciplinary teams should be used for work on multi-host infections.
- Wildlife health units should be established in wildlife and/or veterinary services, according to the specific needs and character of the country.
- Donor support to capitalize capacities, and ongoing government contributions should be ensured.
- Policy and legislation to facilitate the process should now be addressed more widely.

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Discussion

Dr Ithondeka commented that these were good lessons and participants should now ensure that they did not lose the "memory"; GREP must continue to work.

Dr Atang agreed about the need to catch and record the history of this before it died away, and recommended producing a book to document the history of all that had been done. JP15 and AU-IBAR and the importance of regional coordination would be important components. In retrospect, was it possible to explain why rinderpest came back so forcefully after JP15? Was it because of insufficient follow-up and insufficient resources or funding?

Dr Domenech reminded the meeting that JP15 lasted only about ten years, whereas PARC and PACE lasted 20 or more years and had good follow-up. After JP15, the follow-up was not so good and there were no alerts when the disease started to break out from the few areas where it had been allowed to persist.

For *Dr Razzig* it was clear that cooperation was very important at all levels; even with civil unrest in the Sudan it had been possible to work towards the common goal. The result was good for the Sudan, which was now exporting beef more freely throughout the Near East. Now that rinderpest had been eliminated, the resources were available to be used for other diseases.

Dr Al Qadasi reported that a major lesson learned in Yemen was the key role played by international organizations in supporting the country with resources and coordination to achieve rinderpest freedom.

Dr Manzoor Hussain agreed that eradication of rinderpest had given confidence and skills to the veterinary services, and there was need to benefit from this investment – for instance by applying the new skills to PPR.

Dr Saley Mahamadour warned that the veterinary services in many countries did not perform as well as they did in the 1980s, despite OIE support. Diseases of livestock increase poverty, but the veterinary services can only defeat diseases when they have additional support for research and the funding of fieldwork.

Dr Nyager reported that the veterinary services in Nigeria were initiated in 1914 to fight rinderpest, and the structures subsequently put in place had supported the fight against HPAI and other serious diseases. He urged participants not to return to stage one but to push ahead with disease control, not forgetting laboratories and vaccine production. The issue of a national command chain was vital, especially in federal situations where some states act only when directed.

Dr Mariner commented on the need to learn lessons for all other projects, including finishing the job fully. The world's cattle were now almost completely susceptible to rinderpest and the post-eradication strategy must be taken very seriously.

Dr Ghebreigzabiher Ghebremedhin felt that meeting participants were at a starting point. The basic structures and collaboration were in place and must be kept and used to tackle other diseases.

National experience

Chaired by Félix Njeumi

RINDERPEST ERADICATION AND THE WAY FORWARD TO CONTROL PPR IN BANGLADESH

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History of rinderpest eradication

Our first outbreak of rinderpest occurred in 1958 in the eastern region of Sylhet. Vaccination with goat tissue vaccine was used to bring about control, and up to 60 percent of the nation's 23 million cattle were inoculated. The country declared provisional freedom in 2003, and OIE declared Bangladesh free from rinderpest on 25 May 2010.

Post-rinderpest eradication strategy

Rinderpest virus seed has been preserved in the rinderpest section of the Bangladesh Livestock Research Institute. The disease reporting system has been strengthened countrywide. Quarantine measures have been strengthened. Active surveillance is implemented in target areas, and there is enhanced diagnostic capacity and improved outbreak response (rapid, comprehensive and transparent). Biosecurity has been improved on farms and throughout the livestock trade system. Training, education and communication have been increased.

Lessons learned from rinderpest eradication

The availability of a potent vaccine, and strong veterinary and government commitment were the key factors needed to make the rinderpest eradication effort successful. The strengths were:

- the availability of sufficient potent vaccine;
- a good network of veterinary services with sufficient workforce;
- a veterinary diagnostic service network;
- a disease monitoring and reporting system.

The weaknesses were:

- a long porous border with India, with a weak border control system;
- the lack of an animal identification system;
- failure to conduct wide-scale sero-surveillance.

Recommendations for PPR control and eradication

PPR was first confirmed in Bangladesh's 25 million small ruminants in 1990. Since then, the country has improved its surveillance and diagnostic capacity for this disease and increased vaccine production to more than 10 million doses a year. The Bangladesh Livestock Research Institute acts as a subregional reference laboratory for PPR in the SAARC region, and the country is fully engaged in sharing its knowledge of PPR with its neighbours.

Undoubtedly, experience from rinderpest control and eradication measures will help the control and eradication of PPR. The prevalence of the disease is already declining following the government's efforts, and a comprehensive plan for progressive control with a final target of disease eradication could be undertaken. However, assistance from donor agencies and organizations such as FAO will be needed and appreciated.

EXPÉRIENCE DU CAMEROUN DANS LE DOMAINE DE LA LUTTE CONTRE LA PESTE BOVINE

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Introduction

Le Cameroun est honoré d'avoir été invité au Symposium du Programme mondial d'éradication de la peste bovine qui se tiendra à Rome du 13 au 14 octobre 2010 en prélude à la déclaration du Directeur général de l'Organisation des Nations Unies pour l'alimentation et l'agriculture (FAO) sur ce thème. Le Cameroun saisit cette occasion pour remercier la communauté internationale du soutien qu'elle lui a accordé dans sa croisade de lutte contre cette maladie dont les conséquences socio-économiques ont été importantes pour l'économie nationale en général et la vie quotidienne des éleveurs en particulier. Le présent document retrace l'historique de la maladie dans notre pays, met en exergue les enseignements tirés lors des différentes phases de lutte puis examine les perspectives qui s'ouvrent à notre pays à l'issue de cette expérience enrichissante.

Historique de l'évolution des foyers de peste bovine au Cameroun

Au Cameroun, les premiers cas de peste bovine ont été enregistrés et diagnostiqués durant la première guerre mondiale en 1918 par les vétérinaires coloniaux dans les régions voisines du lac Tchad situées dans la partie septentrionale du pays. La maladie avait selon toute vraisemblance été introduite dans le pays par les animaux étrangers venus en transhumance. La région Sud fut par contre épargnée pendant longtemps du fait de sa situation géographique. En effet, elle est séparée de la région Nord par une falaise qui constitue une barrière naturelle difficilement franchissable par les troupeaux des régions septentrionales. Cette zone est également infestée de glossines et n'est par conséquent pas propice au développement de l'élevage. Mais plus tard, le plateau de l'Adamaoua a connu une épizootie de peste bovine très meurtrière entre 1926 et 1927. Après cet épisode, cette région est restée indemne jusqu'en 1960 alors que des foyers épizootiques continuaient d'être enregistrés dans la région Nord. L'application par les vétérinaires coloniaux de diverses mesures telles que l'abattage, l'isolement des animaux malades, l'incinération des cadavres et la vaccination des animaux sensibles, permit de limiter l'ampleur des vagues épizootiques. En 1961, l'Adamaoua, principale région d'élevage bovin du Cameroun, a connu une alerte sérieuse mais rapidement contenue. La maladie ne réapparaît plus dans l'Adamaoua qu'à partir de 1964 puis dans l'Extrême- Nord à partir de 1971. La peste bovine a été réintroduite en 1983 dans les provinces septentrionales du Cameroun par des troupeaux des éleveurs transhumants venus du Tchad et du Nigéria. Ainsi, de nouveaux foyers ont été enregistrés en janvier 1983 dans les régions de l'Extrême-Nord et du Nord et quelques mois plus tard, l'Adamaoua a été atteint. 84 foyers au total ont été recensés dans tout le pays et malgré l'application des mesures sanitaires et médicales, l'épidémie de 1983 a causé la mort de plus de 19 000 têtes de bétail dans la seule province de l'Adamaoua. Cette nouvelle escalade a encore une fois mis en exergue la perméabilité des frontières et le risque sanitaire encouru chaque année pendant la période de transhumance où des centaines de milliers d'animaux étrangers viennent au Cameroun brouter les pâturages de saison sèche des yaérés et du lac Tchad dans l'Extrême-Nord. Pour mener la lutte contre cette maladie, différentes mesures de prophylaxie ont donc été mises en place.

Méthodes de lutte

Les méthodes de lutte contre la peste bovine au Cameroun ont combiné les systèmes de prophylaxie médicale (vaccinations) et sanitaire (abattages suivis d'indemnisations, destruction, désinfection, quarantaine, restriction des mouvements, etc.).

Les campagnes de vaccination du bétail contre la peste bovine ont été organisées dans un premier temps grâce au soutien de la communauté internationale avec la mise en place du Programme conjoint n° 15 (PC15) par exemple, qui se déroula de 1962 à 1976. Le PC15 ne réussit malheureusement pas à endiguer totalement la peste bovine. La persistance de foyers résiduels en Afrique de l'Ouest, au Mali en particulier, et en Afrique de l'Est en Éthiopie et au Soudan, favorisa la réapparition de cette maladie qui envahit de nouveau l'Afrique subsaharienne. Des foyers furent enregistrés dans 18 pays d'Afrique occidentale, centrale et orientale, dans les élevages domestiques comme dans la faune sauvage.

C'est ainsi que la seconde phase de lutte a consisté à mettre en place des plans nationaux de lutte contre cette épizootie, qui ont par la suite été renforcés par la Campagne panafricaine de lutte contre la peste bovine (PARC) et le Programme panafricain pour le contrôle des épizooties (PACE). Ces plans de lutte ont permis de réduire considérablement l'incidence de la maladie jusqu'à son éradication au Cameroun, dans les pays voisins et plus généralement dans toute l'Afrique subsaharienne. Pour mener à bien cette lutte, le Cameroun a eu la chance de disposer d'un Laboratoire national vétérinaire spécialisé dans le diagnostic et la fabrication de vaccins, notamment contre la peste bovine, comme le *Bovipestovax* (vaccin monovalent contre la peste bovine uniquement) et le *Bivax* (vaccin bivalent contre la peste bovine et la péripneumonie contagieuse des bovidés).

Les méthodes de lutte sanitaire ont reposé sur l'abattage des animaux infectés et des animaux des élevages voisins, l'enfouissement des cadavres, la désinfection des lieux, et la mise en quarantaine des animaux lors des mouvements de transit et de transhumance.

Enseignements tirés

L'adoption d'une stratégie de lutte à l'échelle du continent, avec la mise en place du PC15, du PARC et du PACE, s'est avérée payante pour venir à bout d'une maladie dont le caractère transfrontalier est une donnée essentielle avec laquelle il faut compter pour mener un combat efficace.

La collaboration entre des bailleurs de fonds internationaux, comme l'Union européenne, des organismes techniques tels que l'UA-BIRA, la FAO, l'OIE, l'AIEA et bien d'autres encore, et les pays concernés qui ont consenti les efforts nécessaires, a permis à la communauté internationale d'atteindre un résultat historique à savoir:*éliminer la peste bovine de la surface de la Terre.*

Pour préserver cet acquis, il faut par contre rester vigilants et surtout détruire toutes les souches des virus restantes utilisées pour la fabrication des vaccins contre la peste bovine afin qu'elles ne contaminent plus le milieu extérieur ou qu'elles ne tombent pas aux mains des bioterroristes. Au Cameroun, ces souches ont été recensées et on attend la désignation d'une commission chargée de les détruire.

La lutte contre la peste bovine a aussi permis l'adoption d'un plan d'urgence contre cette maladie en cas de réapparition de nouveaux foyers, avec la création d'une banque de vaccins pour le continent, gérée par le Centre panafricain de vaccins vétérinaires (PANVAC).

La lutte contre la peste bovine a également permis au Cameroun, comme d'autres pays africains engagés dans ce processus, de mettre en place *un réseau d'épidémiosurveillance des maladies animales prioritaires*. Il est à noter que c'est ce réseau qui a permis la détection précoce des foyers de grippe aviaire apparus au Cameroun en 2006. Il est donc urgent de pérenniser sa fonctionnalité en finançant ses activités avec le budget de l'État.

La lutte contre la peste bovine a permis à notre pays d'introduire le concept d'indemnisation des éleveurs dont les animaux ont été abattus lors des opérations de prophylaxie. En effet, grâce à cette méthode, les éleveurs ont été amenés à collaborer et par conséquent à participer activement et efficacement à la stratégie de lutte mise en place par le gouvernement.

La lutte contre la peste bovine a permis aussi à notre pays d'entreprendre la vaccination des cheptels contre d'autres épizooties meurtrières telles que la PPCB, les charbons bactéridien et symptomatique et la peste des petits ruminants. Avec la peste bovine, les éleveurs ont compris la nécessité de vacciner leurs animaux contre les grandes épizooties et ils délaissent de plus en plus les méthodes de prévention traditionnelles. La vaccination des cheptels contre les grandes épizooties est désormais une tradition qui s'est ancrée dans la mentalité des sociétés pastorales de notre pays.

Perspectives

Les succès enregistrés dans le cadre de la lutte contre la peste bovine assortis de tous les enseignements tirés lors des différentes étapes qui ont conduit à son éradication, indiquent qu'une stratégie similaire doit être mise en place pour venir à bout des autres maladies prioritaires ou tout au moins les contrôler. Ainsi, il est urgent de mettre en place une stratégie continentale pour l'éradication de la peste des petits ruminants et de la péripneumonie contagieuse des bovidés, ainsi que pour le contrôle de la fièvre aphteuse.

CÔTE D'IVOIRE

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Rappels et historique

A l'instar de nombreux pays de la sous-région ouest africaine, la Côte d'Ivoire a été confrontée aux grandes épizooties de peste bovine des années 1986 qui ont décimé des populations entières de bétail. L'Union africaine (UA) a négocié auprès de l'Union Européenne (UE) le financement, par le Fonds européen de développement (FED), de deux programmes conduits conjointement dans 47 États africains, ce qui a permis la signature des Conventions de financement n° 5224/IVC 7ème FED-REG/5007/001 pour le PARC et 6125/REG/5007/005 pour le PACE. Le suivi de la mise en œuvre de ces programmes a été assuré par le Bureau interafricain des ressources animales (BIRA). Le premier de ces deux programmes est la Campagne panafricaine contre la peste bovine (PARC), une campagne régionale de vaccination contre la peste bovine exécutée de 1986 à 1999. La fin du PARC a été marquée par l'arrêt de la vaccination contre la peste bovine et la mise en place du programme de surveillance.

Le second est le Programme panafricain pour le contrôle des épizooties (PACE), un programme de surveillance de longue haleine. La fin du programme PACE a été marquée par l'obtention du statut de "pays indemne de peste bovine". Au vu de ces résultats de surveillance, le pays est reconnu indemne d'infection par la peste bovine en 2004. Son statut de pays indemne lui est décerné en mai 2007 à la 75^{e} session générale de l'OIE. Chaque année une notification est adressée à l'OIE pour conserver ce statut.

La mise en œuvre de ces deux programmes en Côte d'Ivoire a considérablement modifié la gestion de la santé animale d'une part et les systèmes de production d'autre part.

Impact des deux programmes panafricains de lutte contre la peste bovine

Les programmes PARC et PACE ont eu un impact positif sur le cheptel ivoirien et africain dans le cadre de la lutte contre les maladies animales et l'amélioration de la qualité des produits animaux pour les échanges internationaux. *Ces programmes ont permis entre autres de vacciner contre certaines maladies enzootiques comme la PPCB et la PPR et de maîtriser très rapidement la grippe aviaire en 2006.* Malheureusement, la PPCB et la PPR continuent de sévir en Afrique. Néanmoins, la lutte contre ces deux maladies a produit des résultats.

En outre ces programmes ont apporté un appui aux services vétérinaires dans le domaine du renforcement des capacités mais aussi des institutions, ce qui a permis d'améliorer la notification des foyers. Les notifications à l'OIE se font désormais par Internet sur le site web. Une liste de huit maladies prioritaires a été établie: peste bovine (PB), péripneumonie contagieuse bovine (PPCB), peste des petits ruminants (PPR), peste porcine africaine (PPA), fièvre aphteuse, rage, pasteurellose et brucellose.

La grippe aviaire a été ajoutée à cette liste afin d'harmoniser la lutte avec les pays de la sous-région. Les charbons (symptomatique et bactéridien) ne figurant pas sur cette liste font néanmoins l'objet d'une déclaration tous les ans. La zone de Bouna est reconnue comme un "champ maudit" pour cette pathologie. Ces maladies sont le plus souvent notifiées dans le cadre des informations zoosanitaires.

Au plan de la communication, les activités de diffusion de l'information ont été intensifiées, ce qui a permis un rapprochement avec les organes de communication (télévision, radio nationale, radios rurales, et presse écrite). Cette intensification des activités d'information et de communication a favorisé le changement de comportement et de mentalité.

Au plan du diagnostic des maladies animales, la mise en œuvre des deux programmes a permis de renforcer les capacités du Laboratoire national d'appui au développement agricole (LANADA) à travers ses laboratoires de pathologies animales. Ces laboratoires ont bénéficié de programmes de réhabilitation et d'équipement qui ont amélioré leurs performances.

En ce qui concerne les maladies transfrontalières, le PARC et le PACE ont organisé des réunions transfrontalières. Ces réunions étaient des forums de partage d'informations et de mise à niveau des acteurs de la lutte contre les maladies animales. Des plans d'action contre ces maladies ont été élaborés.

LESSONS LEARNED FROM THE ERADICATION OF RINDERPEST IN EGYPT

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History of rinderpest

Although rinderpest may have previously infected Egypt, the first outbreak to be fully reported and investigated began in 1903 after the importation of infected Asian cattle into Alexandria. The disease persisted until more recent times, when it was brought under control by vaccination with cell culture attenuated vaccine, and the country achieved some years of disease freedom. However, Egypt did not escape the second African pandemic, and the country was reinfected in 1982, with disease then spreading throughout much of the country. Once again, it was controlled and eradicated by inoculation of susceptible cattle with cell culture vaccine, supported by disease surveillance. The last confirmed cases were in 1986. Egypt stopped vaccination of all stock in 1999, and declared provisional freedom from disease. OIE certified rinderpest disease freedom in 2003 and freedom from infection in 2006. The country remains free, and has an appropriate post-eradication strategy based on continuing surveillance.

Lessons learned

The thorough training and dedication of staff to ensure technical competence and understanding of the overall goal were vital. Good communications, to create strong farmers' awareness of the aims and requirements of the programme, was also crucial in gaining farmers' cooperation. Good planning of routine surveillance and special surveys ensured that suitable data were collected for the process of verifying freedom from infection. Constant epidemiological vigilance was necessary to confirm eradication of the disease, and is still required as part of the contingency plan against any possible future outbreak.

Recommendations

- Continued regional cooperation and coordination among countries, for all aspects of the control of diseases of goats and sheep.
- Contingency planning, including training and simulation exercises.
- Close collaboration with global bodies, such as FAO and OIE, to ensure forward planning for new programmes.
- Further training and use – through existing or new veterinary epidemiology networks – of new epidemiological techniques and methods such as risk analysis, geo-referenced mapping, participatory appraisals and database management.

RINDERPEST – A DEVASTATING ANCIENT DISEASE: INDIAN EXPERIENCES AND LESSONS LEARNED

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The disease and its impact

Rinderpest was initially observed in Assam in 1772, followed by numerous fatal outbreaks in other parts of India in cattle, buffaloes, sheep, goats and pigs. Each year, the disease used to affect about 400 000 animals in about 8 000 outbreaks, with up to 50 percent mortality. This virtually crippled the production of meat and milk and all animal-related farm operations, causing serious socio-economic concerns.

Initiatives to curtail the disease

The Government of India appointed an Indian Cattle Plague Commission in 1869 and established the Imperial Bacteriological Laboratory at Pune in 1889. The first batch of anti-rinderpest serum for treating infected animals was issued in 1899. In 1913, the Imperial Veterinary Research Institute, which went on to became the famous Indian Veterinary Research Institute, was established in Izatnagar, and played a pivotal role in the control and eradication of rinderpest through the development and production of hyper-immune serum and vaccines. By 1915, having achieved self-sufficiency, the Indian Veterinary Research Institute started to export to Egypt, the Sudan and the former Rhodesia. For effective prevention, the goat tissue vaccine was prepared in 1927. This, however, had certain side-effects such as abortion and reduction in milk yield. Tissue culture rinderpest vaccine (TCRV), developed subsequently, was safer and cost-effective.

Outbreaks and mass immunization against rinderpest

A National Rinderpest Eradication Programme was launched in 1955/1956 (First Plan), in which cattle and buffaloes over six months of age were mass vaccinated using goat tissue vaccine. Rinderpest was controlled over vast areas of the country. Between 1974 and 1980, the annual incidence decreased from 1 960 to 12 attacks per million bovines. However, sporadic cases of a mild form continued to occur, with occasional outbreaks. Rinderpest also occurred in sheep, goats, pigs and mithuns (*Bos frontalis*) and was controlled by tissue culture vaccine.

Freedom from rinderpest

In 1990, the National Project on Rinderpest Eradication was launched, with assistance from the EU. The project had three phases: a preparatory phase, including vaccine production; an eradication phase, including risk assessment and mass vaccination; and a surveillance phase, with monitoring and surveillance and no vaccination. By 1995, incidence had reduced to one to two cases per million bovines, and the last reported case of rinderpest occurred in Tamil Nadu in September 1995. The last vaccination was carried out along international borders in October 2000. India was declared free from rinderpest in 2003. Between 1955 and 1993, India spent USD 33 357 million on rinderpest control.

Notable achievements of the National Project on Rinderpest Eradication included:

- an ably administered OIE Pathway with effective state-centre coordination;
- strengthened vaccine production, cold chain and transport facilities;
- a central vaccine quality control facility;
- a national network of 32 state-level ELISA laboratories;
- a national facility for ELISA training;
- human resource development through training of more than 250 state-level scientists;
- a national morbillivirus laboratory at the Indian Veterinary Research Institute, Mukteswar;
- a national serum bank facility;
- a national random sampling frame for sero-monitoring and sero-surveillance;
- national emergency vaccine banks;
- print and electronic media for awareness raising;
- indigenous cELISA kits for sero-surveillance;
- declaration of substantial freedom from rinderpest disease by OIE;
- preparation for declaration of freedom from infection by OIE.

Post-eradication developments

Biological materials: A master stock of TCRV seed virus is stored in the country. Potentially infected/virulent samples and virulent challenge virus is stored in a biosecurity level-3 containment facility. Diagnostic facilities for rapid detection of rinderpest are available at national institutes dedicated to livestock health.

Disease surveillance and containment: The laboratory infrastructure has been kept updated and available for virus detection/isolation, sequencing, and molecular characterization of any suspected rinderpest/stomatitis enteritis diseases. More than 1.5 million doses of vaccine are stockpiled for emergency deployment. Field surveillance teams are active for rapid action and immediate containment of any suspected outbreaks. Animal movement along international borders is routinely monitored.

Why did it take so long to curtail rinderpest in India?

- Vaccine coverage in the initial years was only 40 to 50 percent, compared with a target of 80 percent.
- Farmers tended to avoid vaccination of pregnant cows because of a fear of abortion (which is a risk with goat tissue vaccine, but not with TCRV).
- Proper cold chain facilities for the transportation of vaccine to the field were lacking.

- The main focus was on bovines, with little or no attention for small ruminants and pigs.

Lessons learned

- A control strategy should be prepared, taking into account the vast land area covered, the varied species concerned and the socio-economic status of the farmers.
- All vulnerable animal species, not only the important ones, need to be covered. Piece-meal vaccination does not help. It has to be an "all and all" phenomenon.
- Concerted international/regional efforts are required for an effective disease control programme.
- Vaccination can eradicate a disease, and mass vaccination is an alternative to a stamping out strategy, especially for economic and religious reasons.
- The development of vaccine(s) against rinderpest generated a wealth of knowledge in the area of immunology, which can help other disease eradication programmes.
- Coordination between central and state government and among departments of state government is necessary.
- Vaccine quality during production, storage and administration is vital, so uniform standards for the production of vaccine should be adopted and quality control vested with a central authority.
- Indigenous capacity for disease diagnosis, vaccine production and quality control is vital.

RINDERPEST ERADICATION IN KAZAKHSTAN

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The history of rinderpest in Kazakhstan

The first evidence of widespread circulation of rinderpest in Kazakhstan was at the beginning of the eighteenth century in the Semirechya area, where it remained endemic for at least two centuries, causing enormous damage. Eventually, through slaughter of sick and at-risk animals and simultaneous vaccination, the disease was completely eradicated from Semirechya at the beginning of 1910. Official information reports that the last cases of rinderpest in livestock within the territory of the Republic of Kazakhstan were registered in 1927 in the Achmolinsk area, and those within the former Soviet Union as a whole at the end of 1928. Since then, Kazakhstan has been free from rinderpest.

In more recent times, pockets of rinderpest in adjacent countries (Afghanistan, Turkey, Islamic Republic of Iran and Mongolia) posed a constant threat to the territory of Kazakhstan, as shown by outbreaks in the Russian Federation (1991/1992 and 1998) and Georgia (1989 and 1996). To combat this threat, Kazakhstan immunized cattle in a 30-km-deep buffer zone along its borders. The last vaccination against rinderpest was carried out in 2006, using strain K37/70 in 176 600 cattle, predominantly in the Almatin area but also in Mangistaw.

Epi-zootiological monitoring of rinderpest was carried out within the Scientific and Technical Provision for the Monitoring and Genetic Mapping of Disease-Causing Agents of especially Dangerous Infections of Plants and Animals for the Biosafety of the Republic of Kazakhstan project from 2003 to 2006, and by the Scientific and Technical Provision of Biological and Chemical Safety for the Republic of Kazakhstan project from 2006 to 2008. Epidemiological investigations detected no evidence of rinderpest or sero-positive in unvaccinated animals.

The current post-eradication situation

Stored vaccines and virulent viruses: Kazakhstan has no vaccine for use in case of a rinderpest outbreak. However, it does have six vaccine and five virulent strains of rinderpest virus at the National Research Institute, which is a member of the World Federation of Collections of Cultures. These lyophilized viruses are kept in ampoules at -70 °C in a specialized storehouse for OIE group A microorganisms, which was built with suitable systems of physical protection and electronic pathogen detection, using financing from the United States Department of Defence. Before the declaration of global rinderpest freedom, Kazakhstan accepted its obligation to provide safe storage of its rinderpest virus strains within the depository of dangerous pathogens and in conformity with international requirements.

RINDERPEST ERADICATION – THE KENYA EXPERIENCE

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Historically, Kenya has played a great role in the eradication of rinderpest through various research breakthroughs. In 1936, goat attenuated vaccine was brought to the laboratory at Kabete, tested and put into production and use. Avianized and lapinized vaccines were also developed in Kenya. Finally, the tissue culture vaccine was developed at Muguga in 1959.

Recent disease history

In 1986, Kenya bordered two areas known to be foci of rinderpest virus: South Sudan to the north and southern Somalia to the east. Kenya was jolted when two outbreaks of rinderpest reappeared within its own borders that year. Three more outbreaks were reported in 1988, followed by others in 1989 and 1990, which were due to lineage 1 rinderpest virus. Outbreaks were next reported in 1995 (Tsavo National Park) and 1996 (Nairobi National Park) in wildlife and were confirmed to be due to rinderpest virus lineage 2. The species affected were buffalo, lesser kudu and eland. In 1995, no clinical or serological evidence of the disease was found in livestock around the Tsavo National Park, but in 1996, 14 of 23 bovine eye swabs were positive for rinderpest virus antigen in the agar gel immuno-diffusion test. Of 3 423 sera collected, 3 percent were positive for antibodies to rinderpest virus. In late 2001, rinderpest was diagnosed by virus neutralization and PCR tests in buffaloes in Meru National Park, but no live virus was isolated. Sequencing of the viral nucleic acid found it to be 99 percent identical to the 1996 buffalo isolate of lineage 2 rinderpest viruses. Thorough clinical and sero-surveillance was conducted in livestock and wildlife surrounding the national park, but no evidence of disease or infection was found.

In 2003, stomatitis-enteritis cases were detected clinically by participatory disease search in districts of North Eastern Province contiguous to Somalia. Other suspected cases were reported in neighbouring districts in Eastern and Coast Provinces. Five specimens collected and submitted to the Regional Reference Laboratory for Rinderpest at Muguga were positive when tested by PCR, and two were positive in immune-capture ELISA. However, selected positive samples sent to IAH Pirbright for sequencing turned out to be closely related to the Kabete O vaccine strain. Although the results were considered inconclusive, localized vaccination of 140 000 cattle was carried out in December 2003, after which no more cases of this disease were reported.

Control and eradication

Kenya undertook rinderpest vaccinations as a core plan in its rinderpest control and eradication strategy. The country participated in the first major coordinated effort aimed at eradication of rinderpest from Africa, JP15, in the 1960s and 1970s. This programme relied on mass vaccination and confined the disease to more remote areas. The next major effort, PARC, ran from 1986 to 1999 and incorporated sero-monitoring and surveillance as tools for monitoring and evaluating the eradication process. The 1995 and 1996 outbreaks in Tsavo and Nairobi National Parks led to the simultaneous implementation of the Emergency Programme for Eradication of Rinderpest in Kenya in 1996, alongside PARC-Kenya. From 1996 to 1999, the two programmes vaccinated more than 8 million cattle. Sero-monitoring results indicated a herd immunity level of between 58 and 62 percent, nationally. Overall, approximately 40 million doses of rinderpest vaccine were administered between 1986 and 1999, at a total cost of EUR 3 087 775.

The last rinderpest vaccinations in the country were in December 2003, and Kenya was declared free from rinderpest infection in May 2009.

Post-eradication strategy

Currently, 817 300 doses of rinderpest vaccine are stored as a strategic reserve. The Kenya Veterinary Vaccine Production Institute keeps a stock of attenuated Kabete O working master seed for rinderpest virus vaccine production. A number of virulent strains of rinderpest virus are held at the National Veterinary Research Centre, of the Kenya Agricultural Research Institute, Muguga, a biosecurity level-2 laboratory. Currently, no research on rinderpest is ongoing in the country, with the last studies being conducted in December 2005, on heterologous PPR vaccine for rinderpest.

Various activities have been instituted to monitor the possible re-emergence of rinderpest virus. Key among these are a robust epidemio-surveillance system, an emergency preparedness and contingency plan, and a harmonized regional approach to surveillance and other control activities for TADs. Syndromic surveillance in cattle, sheep, goats and wildlife for stomatitis-enteritis syndrome should detect rinderpest-like conditions, as well as PPR and FMD. In June 2010, Kenya participated in joint, cross-border rinderpest simulation and testing of contingency plans with Ethiopia. The lessons and challenges identified from this simulation will be incorporated into contingency plans, thus rendering them more robust.

In mid-2010, Somalia was declared free from infection of rinderpest virus – as the last probable focus of the disease in the Somali ecosystem and worldwide. Celebrations to commemorate rinderpest eradication in Kenya, and final field activities to rid the world forever of this pandemic will be held in late 2010. Whereas the risk from rinderpest has been addressed, cyclical outbreaks of RVF in Kenya not only pose a major constraint on export trade but are also an important zoonosis.

ENSEIGNEMENTS TIRÉS DE L'ÉRADICATION DE LA PESTE BOVINE AU MALI

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Introduction

La peste bovine fit sont apparition en Afrique à la fin du XIX^{e} siècle. À l'époque, cette pandémie aurait détruit près de 90 pour cent des ruminants du continent africain. Ensuite, elle aurait disparu de l'Afrique australe mais serait restée à l'état endémique en Afrique centrale, orientale et occidentale dans les années 50.

La première lutte intégrée contre la peste bovine en Afrique a commencé au début des années 60 avec l'aide de la Communauté économique européenne (CEE), de la Banque mondiale, de l'Organisation des Nations Unies pour l'alimentation et l'agriculture (FAO) et d'autres donateurs, sous les auspices du Bureau interafricain pour les ressources animales de l'Union africaine (BIRA-UA). Cette lutte qui s'est concrétisée dans le Programme conjoint N°15 (PC15) a couvert 22 pays et duré plus de 14 ans, puisqu'elle a démarré en 1962 et pris fin en 1976. Le PC15 a coûté 51 millions d'USD et a permis de vacciner plus de 120 millions de bovins. Ce programme a considérablement réduit l'incidence de la peste bovine, mais faute de mesures conservatoires mises en place par les États, des foyers résiduels en Afrique de l'Ouest (Mali) et en Afrique de l'Est (Éthiopie) ont favorisé la résurgence de la maladie vers la fin des années 70.

Ainsi, entre 1978 et le début des années 80, le Mali, le Sénégal et la Mauritanie ont connu une recrudescence de la peste bovine. Au Mali, les foyers étaient concentrés dans le Gourma (zone pastorale de transhumance que se partagent les régions de Mopti, Tombouctou et Gao) et la zone des lacs de la région de Tombouctou située sur la rive gauche du fleuve. J'ai personnellement été un acteur de cette lutte à l'époque, en ma qualité de Directeur départemental des Services vétérinaires de Tombouctou (1981-1989).

Au Mali, comme dans d'autres pays africains, des campagnes de vaccination d'urgence ont été menées pour limiter la diffusion de la maladie; mais très vite il est apparu nécessaire d'organiser une nouvelle campagne coordonnée à l'échelle du continent africain. C'est dans ce contexte que, sous les auspices de la FAO et de l'OIE, un premier projet de campagne panafricaine de lutte contre la peste bovine, dénommé PARC, a été signé en 1986 entre l'Union européenne et l'Organisation de l'Unité africaine (OUA), pour un montant de 50 millions d'ECU, avec la possibilité pour chaque pays d'associer des conventions spécifiques visant le renforcement des services vétérinaires nationaux et la révision des politiques de développement.

Toujours sur des fonds régionaux du FED au titre du Programme indicatif régional (PIR), deux autres propositions globales ont été signées en 1990 et 1995. Mais, dès 1993, les conventions globales ont été complétées par des conventions spécifiques avec différents pays, sur des programmes nationaux (PIN). C'est ainsi que le projet PARC Mali III financé par le FED à hauteur de 3 600 000 ECU a été mis en place avec quatre composantes:

- appui institutionnel à la Direction de l'élevage, avec un volet santé animale centré sur la peste bovine mais aussi sur la PPCB et la brucellose, le développement de l'épidémiologie, le suivi zootechnique et le suivi des écosystèmes pastoraux, pour 2,6 millions d'ECU;
- appui aux groupements d'éleveurs, pour 580 000 ECU;
- appui à l'installation des membres inscrits au tableau de l'ordre des vétérinaires, pour 600 000 ECU;
- appui au Laboratoire central vétérinaire (formation), pour 128 000 ECU.

Dès lors, il est perceptible que le PARC Mali, dans ses phases successives, a cerné plusieurs aspects ce qui lui a permis de déboucher sur des résultats plus durables que ceux du PC15. Parmi ces aspects supplémentaires cernés par le PARC, citons les suivants:

- l'éradication du virus pestique au Mali;
- l'utilisation de la sérosurveillance pour contrôler l'efficacité des vaccinations, après chaque campagne;
- l'utilisation des médias pour sensibiliser et informer les éleveurs;
- le contrôle régulier, par PANVAC, des vaccins produits par le Laboratoire central vétérinaire avant qu'ils soient mis à la disposition des équipes de vaccination;
- la participation de vétérinaires privés légalement installés aux campagnes de vaccination;
- le recouvrement des coûts des vaccinations auprès des éleveurs;
- la création d'un Fonds pour le développement de l'élevage;
- la restructuration des services vétérinaires pour confirmer l'État dans son rôle de contrôle régalien, en confiant les prestations vétérinaires et la vente de médicaments à des vétérinaires privés qui récupèrent les coûts correspondants auprès des éleveurs;
- les aménagements pastoraux (gestion de l'espace pastoral, création de points d'eau, remise en état des écosystèmes), le bornage des pistes de commercialisation et de transhumance, et l'aménagement des marchés à bétail ont permis un suivi très rapproché et plus facile du cheptel (surtout transhumant).

Cette panoplie de mesures a favorisé une vaccination correcte des troupeaux transhumants qui, durant l'exécution du PC15, avaient souvent échappé aux équipes de vaccination. Les résultats étaient au rendez-vous car les enquêtes de surveillance des anticorps antibovipestiques effectuées entre 1989 et 1994 attestent d'une bonne couverture immunitaire du cheptel bovin malien (environ 80 pour cent). Ainsi, depuis 1986, le Mali n'a pas enregistré de foyer de peste bovine. Toutes les conditions étaient donc réunies pour que le pays adhère au Programme mondial d'éradication de la peste bovine (GREP) de la FAO qui a élaboré des stratégies de surveillance de la peste bovine, appelées "procédures de l'OIE", dans l'objectif de déclarer son territoire indemne de la peste bovine.

Ainsi, après l'acquisition du statut de pays provisoirement indemne de la peste bovine, le réseau de surveillance épidémiologique vétérinaire du Mali (Epivet Mali) a été mis en place. Ce réseau, aujourd'hui fonctionnel, est constitué d'une unité centrale, de cinq unités régionales, de 35 postes d'observation et de groupements d'éleveurs. Ce dispositif est coiffé par un comité de pilotage. Les surveillances clinique et sérologique de la peste bovine sont régulièrement effectuées et les résultats sont diffusés dans un bulletin trimestriel d'information édité par l'unité centrale.

En conclusion, on peut dire que, comparé au PC15, le PARC a permis d'atteindre des résultats concrets parce qu'il a pris en compte beaucoup de facteurs intéressant tous les intervenants (État, acteurs privés, éleveurs) et a encouragé les aménagements pastoraux pour favoriser les conditions d'élevage et l'accès aux troupeaux transhumants, dont le suivi et la vaccination régulière posaient problème.

Tous ces facteurs agissant de façon synergique ont permis un développement harmonieux de l'élevage au Mali et produit des avantages économiques certains au plan national et international. Concrètement, des abattoirs nouveaux ont été construits (Bamako rive droite, Ségou, Sikasso, Kayes et Mopti) et les exportations vers la Côte d'Ivoire, le Ghana, le Libéria et le Sénégal ont considérablement augmenté. Dès lors, la consommation intérieure de viande a progressé, et les revenus des éleveurs et des agro-éleveurs sont devenus importants. Enfin, la culture attelée s'est beaucoup répandue au Mali, ce qui a favorisé l'augmentation de la production agricole.

Par ailleurs, l'organisation mise en place pour éradiquer la peste bovine a servi pour le contrôle d'autres maladies non moins importantes comme la PPCB, la fièvre aphteuse, la peste des petits ruminants, la grippe aviaire, la brucellose et les septicémies. Aujourd'hui, la PPCB handicape beaucoup de paysans car elle touche en zone agricole les bœufs de labour. Dès lors, la FAO doit inciter les donateurs et les pays en développement à unir leurs efforts pour éradiquer la PPCB.

RINDERPEST ERADICATION FROM NEPAL: OPPORTUNITIES, CHALLENGES AND FUTURE TASKS

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Rinderpest was an unforgettable experience for Nepalese farmers, who observed how devastating the effects of an outbreak can be in a village, and the subsequent disruption of agricultural farming systems leading to famine. Mass vaccination against the disease helped to develop farmers' faith in vaccination as a tool for animal disease control. A national veterinary service was established in the wake of rinderpest outbreaks, and the concept of animal quarantine was introduced for rinderpest control.

The rinderpest eradication campaign launched during the 1970s in Nepal and neighbouring countries clearly demonstrated that mass vaccination and animal quarantine measures can bring down the number of cases towards zero, but that the disease may re-emerge after many years.

In the 1990s, the European Commission-funded strengthening of veterinary services and livestock disease control project in Nepal and neighbouring countries was instrumental in building national capacity to eradicate rinderpest and make it history.

Our experience shows that eradication of TADs is impossible without regional/global cooperation.

RÉPUBLIQUE DU NIGER

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Le Niger dans la procédure OIE d'éradication de la peste bovine

À la fin de l'année 1999, le Niger s'est auto-déclaré pays provisoirement indemne de la maladie, avec notification à l'OIE, au Bureau interafricain pour les ressources animales de l'Union africaine (BIRA-UA) et aux pays voisins. Un réseau d'épidémiosurveillance a alors été mis en place pour assurer la surveillance épidémiologique selon les directives de l'OIE en 2001 et 2002; en novembre 2002, le Niger a envoyé à l'OIE son dossier en vue d'obtenir le statut de pays indemne de la maladie. Lors de la session générale de l'OIE de mai 2003, ce statut lui a été reconnu. De 2003 à 2005 les résultats de la sérosurveillance ont révélé une agrégation des animaux séropositif venant d'un pays limitrophe avec des séroprévalences souvent très élevées. Il était difficile de se faire une idée précise de la situation, en raison des disparités apparentes entre les données dont la présentation n'est pas harmonisée. Le dossier du Niger n'a donc pas été agréé et le pays a été invité à procéder à de nouvelles investigations en particulier dans la région concernée de Zinder. De 2005 à 2009, la méthodologie utilisée considérait le Niger comme étant une strate unique à l'image de tous les pays ouest-africains, c'est-à-dire dépourvus de barrière naturelle ou artificielle qui empêcherait les animaux sensibles à la peste bovine venus des quatre coins du Niger de se rencontrer. Les résultats de cette sérosurveillance n'ont révélé aucun indice de circulation du virus bovipestique sur l'ensemble du territoire du Niger. Lors de la session générale de l'OIE de mai 2010, le Niger a obtenu son statut de pays indemne d'infection par la peste bovine.

Enseignements tirés et évaluation des impacts

Sur le plan technique et méthodologique: L'approche intégrée du GREP, de l'OIE et du BIRA-UA a permis aux pays africains d'unir leur efforts en vue d'éradiquer la peste bovine. Le problème du difficile contrôle transfrontalier des mouvements des animaux, qui est une donnée permanente en Afrique, a ainsi été résolu. La coordination de cette activité à l'échelle du continent a en effet permis de synchroniser les actions et, ce faisant, de renforcer les capacités des États en matière d'éradication de la peste bovine. Par ricochet, la mise en place dans chacun des États d'un réseau d'épidémiosurveillance des maladies animales a permis de disposer d'un instrument capital pour le contrôle et la maîtrise de l'ensemble des maladies animales importantes.

Cette approche a également permis aux États de se doter d'un autre instrument stratégique, le "Plan d'intervention d'urgence" contre la peste bovine. L'adoption de ce plan a démontré que l'État nigérien était déterminé à agir pour éradiquer définitivement cette maladie de son territoire. Ce plan d'intervention d'urgence constitue un document stratégique qui garantit entre autres que:

- toutes les actions nécessaires ont été recensées et définies à l'avance,
- toutes les ressources humaines, matérielles et financières sont définies et leur mobilisation assurée,
- toutes les ressources seront utilisées de manière efficace.

Le Plan a en outre l'avantage de définir la séquence d'actions à mettre en place et la responsabilité des différents acteurs intervenant dans l'éradication d'un foyer confirmé de peste bovine réapparu sur le territoire nigérien.

RINDERPEST ERADICATION IN NIGERIA: LESSONS LEARNED AND THEIR APPLICATION TO THE CONTROL OF OTHER TADS

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Introduction

Nigeria has 36 states and a Federal Capital Territory. Agriculture, including livestock development and control of animal diseases, is on the concurrent list of the Nigerian Constitution. Through this, the Constitution provides that states bear the responsibility for animal disease control. Rinderpest and CBPP are two important diseases that have been recognized in Nigeria since the nineteenth century. Rinderpest was introduced through Chad, where it was recorded in 1886, killing 80 to 90 percent of the cattle population of that time. Other disastrous epidemics of rinderpest occurred in 1913 to 1914, and 1919 to 1920, causing mortality rates in the range of 60 to 90 percent.

Strategies for the control of rinderpest: a Nigerian perspective

The first step towards rinderpest control and eradication in Nigeria was initiated by the United Kingdom Colonial Government with establishment of the Veterinary Department in Zaria in 1914. Legislation for disease notification and control was promulgated in 1924, and a veterinary laboratory was established in Vom for research, diagnosis and production of vaccines. By 1930, a network programme for voluntary anti-rinderpest vaccination was established, which reduced mortality to between 5 and 20 percent in affected herds. In 1960, outbreaks of the disease began to become more frequent, and in 1962 Nigeria joined JP15. At the end of this campaign, in 1965, the disease was eliminated. However, in 1980, owing to the relaxation of control measures, rinderpest re-entered Nigeria through infected cattle from the Niger. In January 1983, a second more virulent strain of rinderpest virus entered Nigeria around Dikwa in Borno State, via Chad and Cameroon. A total of 1 081 outbreaks were recorded, leading to the death or slaughter of more than 500 000 head of cattle between 1980 and 1987.

In 1983, the Federal Government launched the National Rinderpest Control Programme. A National Rinderpest Coordinating Committee was constituted, chaired by the Federal Department of Livestock, and developed strategies aimed at controlling the disease. Ring and mass vaccinations were instituted strategically. The cost was borne largely by the Federal Government with assistance from the EU and FAO. PARC commenced in Nigeria in 1989 and was a huge success. A sero-monitoring programme began in 1987. In 2001, the EU/AU-IBAR-sponsored PACE programme commenced. Nigeria attained disease-free status and was certified as such by OIE Standards in 2010. Table 1 shows the reported rinderpest outbreaks from 1983 onwards.

TABLE 1
Outbreaks of rinderpest and field activities in Nigeria, from 1983

Year	No. of outbreaks	In-contact animals	Morbidity	Mortality	Vaccine doses issued	Vaccination returns
1983	1 081	6 691 428	2 422 835	500 158	15 916 700	11 350 812
1984	329	53 908	16 493	7 659	11 173 600	8 306 048
1985	39	7 547	1 038	520	10 179 000	7 803 633
1986	2	415	85	53	7 869 900	5 897 783
1987	1	507	300	173	8 792 700	7 824 898
1988	0	0	0	0	5 185 900	4 160 267
1989	0	0	0	0	2 166 000	2 211 471
1990–2010	0	0	0	0	0	0

Lessons learned from rinderpest eradication, and their application to the control of other TADs

Holistic approach and regional coordination: The global eradication of rinderpest serves as important proof that when dealing with livestock diseases with serious economic consequences, concerted efforts and a holistic approach are required to achieve a desirable result. The experience also provides an indication that good understanding of the epidemiology of diseases, good planning and timely execution of activities, effective disease surveillance and reporting systems, improved laboratory diagnostic capabilities, adequate funding, and strategies coordinated at the regional level will most likely lead to the control and eradication of other TADs in Africa, particularly Nigeria (Vakuru, 2004; 2005).

Awareness of immunization benefits: The participatory and community-oriented approaches that were adopted in Nigeria and elsewhere for rinderpest control and subsequent eradication had positive impacts on behavioural changes among rural livestock owners, particularly pastoralists. For instance, before commencement of the rinderpest eradication programme, it was almost impossible for public health officials to convince pastoralists to bring their children for immunizations. However, when the pastoralists observed that vaccination against rinderpest was very effective in protecting their cattle against the disease, they believed that immunization of their children would likewise protect those children. Thus, pastoralists' acceptance of immunization was indirectly encouraged by the rinderpest campaign. This point, although subtle, is very important, as it demonstrates links between veterinary and public health activities, particularly at the rural community level.

Organizational structure: A well-defined and unambiguous organizational structure with a definite command chain down to the grassroots, from central to state veterinary services and local governments, facilitated the eradication of rinderpest in Nigeria. This could be adopted for other TADs, and would involve functional units within the various tiers of government, with well-defined tasks and responsibilities. For instance, states should have budgetary and workforce resources for carrying out disease control programmes for TADs in consultation with the Federal Government.

Locally produced vaccines and campaign management: Vaccine supplies in Nigeria were inadequate at the initial stage. However, with enhanced in-country vaccine production capacity, good handling and distribution chains, timely logistics and funding support, and the stockpiling of essential veterinary products, the situation was remedied. This strategy will most likely also be effective in the control of other TADs.

Communication strategies: The use of traditional institutions, livestock owners' associations and government extension workers enhanced the dissemination of information for the eradication of rinderpest in Nigeria. Comprehensive and well-articulated communication and advocacy strategy plans will be required for the control of other TADs.

Effective monitoring: Centrally coordinated, well-funded and effective monitoring of field workers, vaccine production and sero-monitoring/surveillance activities facilitated the timely correction of mistakes and application of alternative measures, where necessary, during the rinderpest control campaign in Nigeria (Majiyagbe *et al.,* 1992). This approach will be of tremendous importance when applied to the control of other diseases.

Comprehensive contingency plan: Development and implementation of a comprehensive and well-structured contingency plan for all TADs, taking into consideration the specific features of regions and territories, is crucial. Well-planned and executable pathways for the control and eradication of such diseases, building on existing structures and reviewing/updating or formulating enabling legislation with regional applications, are very important. Livestock movement control, disease control and reporting, certification of livestock and livestock products, etc., and current data on livestock populations at the national level are useful in planning livestock activities. Well-planned, harmonized and fully funded programmes utilizing vaccination, cross-border collaboration, good laboratory support, skilled human capacity and efficient logistics support for all veterinary activities are keys to successful control and eradication programmes for all TADs.

Conclusion

Global rinderpest eradication is one of the best things that ever happened to the livestock industry. The application of similar strategies to the control of other TADs is desirable, feasible and realizable.

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THE 1980s RINDERPEST EPIDEMIC AND PPR IN NIGERIA

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JP15 against rinderpest was highly successful, but left some foci of disease in western Africa. Nigeria, which was free of rinderpest from 1974 to 1980, became infected with minor outbreaks in its western states in the early 1980s (Nawathe and Lamorde, 1982). Soon after, a wave of outbreaks from eastern states occupied the whole country from 1983 until a final outbreak in 1987. More than 500 000 cattle died, at a loss of USD 2 billion, along with many wild ungulates in the game parks (Nawathe and Lamorde, 1983; 1984). Two virus strains existed during the epidemic: earlier ones belonged to lineage 2; and a later one belonged to lineage 1 (Wamwayi, Fleming and Barrett, 1995). What helped most in controlling the outbreaks was closing of the country's borders when the new government took over in January 1984 (Nawathe, 1984). I am glad that rinderpest is finally eradicated by international effort, and experiences will pave the way to do the same with other epidemic diseases.

PPR was, and remains, endemic in sheep and goats in the humid zone of West Africa. TCVP protected against the disease and was found safe, even in pregnant goats. However, our experience of vaccinating animals from the endemic zone, or animals purchased from the market, presumably incubating disease, was that it was often followed by more clinically severe disease in some animals (Nawathe, 1984).

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EXPERIENCES AND LESSONS LEARNED DURING THE ERADICATION OF RINDERPEST IN PAKISTAN

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Introduction

Rinderpest, affecting mainly cattle and buffaloes, was present in the region since the creation of Pakistan in 1947. However, the disease was officially recognized in the country during 1994 when it was confirmed in buffaloes in Landhi Dairy Colony Karachi by the World Reference Laboratory, United Kingdom. After a classical outbreak of rinderpest in the Northern Areas (now Gilgit Baltistan Province) during 1994/1995, concerted efforts were made by the national veterinary authorities to eradicate rinderpest, with the technical and financial support of FAO, the EU and IAEA (Rossiter *et al.,* 1998).

A review of the disease control capacities of animal health services revealed a number of inadequacies, such as lack of well-defined disease control policies at the federal and provincial levels, inadequate diagnostic facilities, poorly performing disease reporting systems, and lack of contingency plans, particularly for the control of TADs. Epidemiological investigations confirmed that there was a need to improve surveillance and diagnostic facilities in the country. The Government of Pakistan's commitment and financial and technical assistance from EU, FAO and OIE were therefore sought to improve animal health service capabilities.

Participatory disease surveillance, introduced with FAO support, proved to be an excellent method for collecting data about the possible presence of rinderpest and other animal diseases, including TADs, according to farmers' perspectives. More than 10 000 villages were searched using participatory disease search methodology between 2002 and 2005; the data gathered indicated the importance of various diseases and provided strong evidence that rinderpest was not present in Pakistan after September 2000 (Mariner *et al.,* 2003; Hussain *et al.,* 2005). The use of rinderpest vaccine was officially prohibited in December 2000. Subsequent national serological surveillance in 2003, 2004 and 2006 found no evidence of circulating rinderpest virus in susceptible species, and Pakistan was declared free of rinderpest in 2007.

Lessons learned

- The lack of animal disease control policies at the federal and provincial levels and of a national animal disease control programme for rinderpest delayed rinderpest eradication.
- Absence of a strong surveillance system in Pakistan meant that it took a long time to gather information on disease patterns in the country.
- Inadequate networking among diagnostic laboratories within the country, and limited interaction with the World Reference Laboratory hampered early diagnostic confirmation and concomitant disease control actions.

- Field experience indicated that it was impossible to control/eradicate the disease if poor-quality vaccine was used or a cold chain was not maintained for work in the field. The subsequent use of quality-assured rinderpest vaccine was important for eradication of the disease.
- Eradication awareness campaigns for all stakeholders played an important role in the ultimate eradication of rinderpest from Pakistan. Training workshops, posters and brochures all played roles in generating community cooperation and promoting the recognition and reporting of rinderpest or rinderpest-like diseases.

Recommendations for future animal health programmes

- A national policy and programme should be in place for the control and/or eradication of all important livestock diseases. It should be well-supported, both technically and financially, by national and/or international agencies.
- Selection of a strategy for the control/eradication of a disease is of primary importance. Efforts should be made to keep the ground realities in mind and to identify measures that could be implemented to achieve targets.
- A participatory epidemiology centre should be established in the country. As well as improving disease surveillance, this centre could train human resources in different areas of veterinary and public health.
- Quality-assured, cost-effective vaccines should be available in the country.
- A regional diagnostic centre should be established to provide guidelines and continuous training to member countries. It should assist the improvement and standardization of laboratory procedures.
- Livestock departments should provide their field veterinarians with in-service training courses in outbreak investigation and control strategies.

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RINDERPEST ERADICATION IN THE RUSSIAN FEDERATION: LESSONS LEARNED AND FUTURE TASKS

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Introduction and history

Rinderpest had not been registered in the Russian Federation since 1928. In 1991, two cases were reported from the Chitinskaya Oblast (July) and the Republic of Tuva (October). The last case of rinderpest was registered on August 1998 in the settlement of Simonovo, Shimanovsky Rayon, Amurskaya Oblast. In this final outbreak, the morbidity rate in 150 susceptible animals was 70 (47 percent), and the overall mortality was 42, giving a case mortality rate of 60 percent. Of 70 infected animals, 23 percent were adults and 77 percent were young stock aged eight to 18 months. All sick animals were slaughtered on 22 August, no new cases occurred, and all restrictions were lifted on 1 October 1998. Specific rinderpest vaccine was used in a rinderpest prevention and control programme in the Russian Federation until 2001. A zone of protective cattle immunization, one to two rayons (administrative units) deep, was established in selected regions of Siberia and the far east bordering China and Mongolia, and in the Vladimir region (where the Federal Service for Veterinary and Phytosanitary Surveillance and the All-Russia Research Institute of Veterinary Virology and Microbiology are situated). The two rinderpest vaccines used for the vaccination were strain LT and NISHI K37/70.

The strategy

An infectious disease can be eradicated globally only when it is eliminated in every country, and so the main goals in the Russian Federation were to:

- eliminate the disease;
- confirm its elimination;
- prevent its introduction from outside.

Achieving these goals required:

- standardization of conventional and new molecular methods for virus differentiation and identification;
- development of new methods for disease diagnosis and control: serological (ELISA) and molecular (PCR) diagnostic tools were developed to detect antibodies and identify viruses, for monitoring the effectiveness of vaccination campaigns and implementing disease surveillance when vaccination was no longer carried out; effective ELISA kits allow us to:
  - identify specific virus antigen;
  - determine the level of maternal antibodies;
  - predict the decline in maternal antibody levels precisely;
  - evaluate vaccination efficacy (immunity level);
  - start vaccination as soon as possible without interference from the field virus;
  - adjust the vaccination programme according to serologic profiles for normal and mixed herds;
  - determine possible contact with the field virus;

- collection, processing, analysis and dissemination of information about animal diseases;
- coordination of collaboration with other laboratories and organizations in the field of research and technological development.

Lessons learned

One important factor was the *sound choice of disease for eradication*. In theory, rinderpest is an easy disease to eradicate because animals that recover are immune for life, the virus does not survive long outside the body, and it is transmitted by direct contact between animals. As a result, the disease always needs to find new, susceptible individuals to survive. Vaccination reduces the number of these susceptible animals, and *vaccines have contributed massively* to the control of rinderpest. However, vaccines alone would not have succeeded had diagnostic tests for rinderpest not been developed. It is also necessary to *fund and support* this investment adequately. That the battle against rinderpest has been so successful is a testament to the *persistence and passion shown by many people*, including scientists and veterinarians in both developed and emerging countries, and officials in organizations such as FAO and OIE.

The Russian Federation's contribution to the global success of eradicating rinderpest lay in *preventing the virus's reintroduction* along the country's southern border, through the use of disease diagnosis, systematic surveillance, vaccine and zoo-sanitary controls.

Conclusions and recommendations

The eradication of rinderpest through large-scale vaccination and surveillance campaigns has been a remarkable triumph for veterinary science. It serves as a powerful example of what can be achieved when the international community, individual national veterinary services and farming communities cooperate to develop and implement results-based policies and strategies. It clearly shows that eradication of an animal pathogen may be feasible, and this may be increasingly important for both humans and animal pathogens. The experience gained during implementation of GREP should be used for the eradication of other TADs.

In future it will be necessary to define a policy for available rinderpest virus strains and vaccine reserves in the Russian Federation. Scientifically, the possibility of developing live rinderpest virus-free diagnostic kits and vaccines against rinderpest needs to be considered.

THE SUDAN: EXPERIENCE AND LESSONS LEARNED IN THE ERADICATION OF RINDERPEST

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Rinderpest eradication

Rinderpest first entered the Sudan through the eastern border in 1899. All rinderpest viruses analysed from the Sudan have been of the African lineage 1 type, causing moderate to severe clinical signs in cattle. Rinderpest virus African lineage 2 has not been detected in the country. Many outbreaks occurred between 1980 and 1983, and in 1983 and 1984 a serious epizootic of rinderpest killed almost 500 000 cattle in Darfur and Kordofan. In northern Sudan, the last outbreak of rinderpest was reported in Lagawa province, West Kordofan State in 1990.

In South Sudan, rinderpest outbreaks were widespread in the early 1990s. Vaccination campaigns carried out by the Operation Lifeline Sudan (OLS) Livestock Programme from 1993 to 2002 reduced the number and severity of these outbreaks drastically. Classical severe rinderpest of African lineage 1 was last confirmed in cattle in 1998 by the FAO World Reference Laboratory for Rinderpest (Pirbright, United Kingdom) from samples collected in the Lopit hills of Torit county, East Equatoria State in southeastern Sudan. Continuing intensive surveillance by the Government of the Sudan, assisted by NGOs working under the OLS Livestock Programme, AU-IBAR's PARC, and GREP, through FAO's TCP, confirmed the absence of rinderpest from central Sudan and indicated that the persistence of rinderpest infection was limited to areas in the southeast of the country. Following focused surveillance and vaccination in the different communities of cattle in this area, vaccination was stopped in late 2002. This was followed by intensive disease and serological surveillance, and OIE recognized the Sudan as being free from rinderpest infection in May 2008.

Key issues in successful eradication

Vaccines: From 1968 onwards, the cell culture attenuated Kabete O strain of vaccine was used throughout the Sudan. During PARC and PACE, vaccine was certified by PANVAC, Debre Zeit, Ethiopia. In 1993, the thermo-stable form of the same vaccine was imported from Botswana for use predominantly in remote areas where provision of a cold chain was difficult. This proved to be very successful when used by CAHWs under veterinary supervision, especially in South Sudan.

National coordination: Throughout much of the period of rinderpest's eradication from the Sudan, the country was affected by warfare, with areas outside government control, especially in the south. In these circumstances, particularly good coordination was vital to achieving the goal. The final success in the Sudan testifies to this good coordination and the effort that went into it, and illustrates what can be achieved when all parties unite for a common good. The General Directorate of Animal Health and Epizootic Diseases Control, at the federal level, and the Directorate of Veterinary Service within the Ministry of Animal Resources of the Government of South Sudan supervised activities related to the rinderpest eradication strategy. There were direct contact and coordination between these directorates and the departments of animal health and disease located in the 25 states. The Sudan Veterinary Council also supervised and regulated private veterinarians who were involved in preventive services.

The European Commission-funded PACE Fight against Rinderpest Lineage 1 project was implemented in the Sudan with the main objective of eradicating rinderpest. The project was divided into two sub-projects: one for the government operation areas – the northern sub-project; and another for the non-government operation areas – the southern sub-project. The southern sub-project started in November 2001 and was predominantly operated through NGOs, with overall coordination being managed by *Vétérinaires Sans Frontières* (VSF)-Belgium based in Nairobi. The northern sub-project commenced 16 months later, in February 2003. It operated through conventional government channels managed by the

Federal Department of Animal Health and Epizootic Diseases Control, Ministry of Animal Resources and Fisheries in Khartoum. There were continual close contact and communication between the two sub-projects.

Disease surveillance: The Sudan has a national epidemio-surveillance system that includes the reporting of all notifiable diseases. During rinderpest eradication, this was particularly sensitized towards rinderpest. The system worked at a number of interrelated levels, including passive or routine reporting from states, targeted searching for clinical rinderpest in cattle in suspected high-risk area, livestock market searches, participatory disease searching, and slaughterhouse searches. A system of "activated syndrome reporting" for stomatitis-enteritis became very well established in the south, supported by a network of NGOs, international organizations and a reward of USD 500 (later increased to USD 1 000) for any stomatitis-enteritis reports that led to a laboratory-confirmed rinderpest outbreak. All suspicious outbreaks were notified and followed up for more information and full laboratory confirmation. A substantial number of stomatitis-enteritis cases were reported, but none was confirmed as rinderpest. Serological surveillance of cattle and wildlife was carried out to confirm the absence of any undetected infection.

Maintenance of freedom from rinderpest: Rinderpest emergency preparedness plans are in place in northern and southern states. The surveillance system developed during the eradication of rinderpest is still largely in place, fulfilling the conditions for surveillance for rinderpest disease in accordance with Appendix 3. 8. 2 of the Terrestrial Animal Health Code, together with suitable regulatory measures for the prevention and control of rinderpest.

Achievements and lessons learned

Rinderpest caused considerable damage to the Sudan's animal resources and was the main constraint to livestock development nationwide. The country's fight against rinderpest continued for more than 100 years, and the cost of control and eradication was huge. Now however the eradication of rinderpest and the capacity built during the eradication period have enabled the Sudan to *sustain exports* to traditional markets and to *open new markets* for the export of live animals and meat throughout the region. During 2009, 1.5 million sheep, 140 630 goats, 19 265 cattle and 154 447 camels were exported, allowing the Sudan to utilize its impressive animal resources *for improved food security*.

Despite the civil unrest prevailing in the Sudan for more than 20 years from 1983, the rinderpest eradication programme and verification of freedom were implemented and executed effectively. This was mainly owing to *cooperation and joint activities among all stakeholders* and *support from the international community,* whose role in the fight against rinderpest in the Sudan is highly appreciated and acknowledged.

The experience and the capacity built in the country using the resources provided by national, regional, continental and international rinderpest control programmes now constitute a solid national base for controlling and eradicating other transboundary diseases. It is now our policy that the efforts and resources that were used for controlling rinderpest be redirected to *control and eradication of other important transboundary diseases*.

YEMEN: LESSONS LEARNED DURING RINDERPEST ERADICATION

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Introduction

Rinderpest was first confirmed in Yemen in the Highlands and Tihama between 1971 and 1972. These outbreaks were brought under control with the help of international assistance, including from FAO, and proved to be the stimulus for establishing a veterinary service in Yemen. Rinderpest control based on vaccination and increasingly effective surveillance and laboratory diagnosis brought the disease to the point where the last cases were reported from Yemen in 1995. No rinderpest has occurred since then, and by following the recommended surveillance procedures of the OIE Pathway, Yemen was certified free of rinderpest by OIE in 2010. This success has given us numerous positive lessons to draw on for the future.

Lessons learned

First and foremost – eradication worked. It is possible to eradicate a disease from Yemen. The animal health service clearly functioned, and we acknowledge the support that we received initially from the United Kingdom Government's veterinary team in Yemen and latterly from FAO and the Joint FAO/IAEA Division. The animal health service was obviously able to deliver sufficient disease control and disease surveillance and to back these up with good laboratory analysis. There were also sufficient funds and commitment to do all of this.

Eradication in isolation does not work (or not for long), and we now appreciate how vital regional and global coordination was to us. This coordination provided:

- techniques and tools;
- technical and laboratory back-up;
- funding;
- cross-border information;
- training and other opportunities for learning;
- motivation – field allowances, funds for work, and shared senses of purpose and achievement.

We can now look back and see that it was not really that difficult, technically. Vaccination and surveillance were our two main tools; we used reliable vaccines, simple and consistent laboratory tests for diagnosis and for detecting antibodies, and good operating practices for surveillance. It was a matter of sticking to the task at hand, with perhaps a little luck in some places where the disease disappeared more easily than expected. We did not use slaughter and compensation, and applied only minimal movement control. Ear notching was attempted, but unevenly applied, although old notches certainly helped us to clarify some of our serological results.

As a result of the rinderpest programme we now have a pool of skilled staff who have been motivated by further training in surveillance and by being part of a programme that encouraged and facilitated their work in the field, provided opportunities to earn more income, and led to a rewarding professional outcome. In recent years, these human resources have helped us to combat other serious diseases of livestock, including our first experiences of RVF and Old World screwworm infestation. Besides responding to such emergencies, our challenge now is to apply these resources and our newly learned lessons to a focused programme of improved control and possible eradication of other livestock diseases in Yemen.

Diseases that we are considering for this include our most widespread and serious infectious disease, PPR, as well as goat pox and other problems of small ruminants. We are not in a position to mount an immediate new national programme ourselves, owing to a number of constraints including funding, and would welcome the opportunity to join a new regional or global initiative against diseases such as PPR. While waiting for such an initiative to be formulated and become operational, we propose to start with smaller schemes aimed at improving local understanding of the epidemiological mechanisms for PPR in Yemen and identifying high-risk areas where we might experiment with more broadly based vaccine delivery systems that we have used before. We do not want to miss the opportunity that rinderpest eradication provides for improving disease control in Yemen, to increase livelihoods and food security.

Individual experiences

Chaired by Dr Yoshihiro Ozawa

SOME MODELS APPLIED TO THE GLOBAL ERADICATION OF RINDERPEST

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Chairman, Joint FAO-OIE Committee on Global Rinderpest Eradication

Introduction

Rinderpest has only ever existed through straightforward transmission from an infected to a susceptible host. It has been eradicated by the simple expedient of breaking this transmission chain. Different countries have adopted different models of how to go about this process, which are exemplified in the following.

The zoosanitary model

The application of detailed zoosanitary measures to constrain outbreaks of rinderpest was first proposed by Lancisi (1715), who advised that the disease spread from sick cattle to healthy ones and recommended stamping out (slaughter, burial, disinfection, closure of markets, movement controls) as an effective method of control. In the eighteenth and nineteenth centuries, legal measures for the enforcement of zoosanitary controls were introduced across Europe and were ultimately effective in freeing that continent from the disease (Spinage, 2003).

Models using vaccine

Edwards' Myanmar vaccine model, 1936 to 1940: Shortly after developing the goat attenuated strain of rinderpest, and long before the concept of global rinderpest eradication was mooted, in Myanmar, J.T. Edwards (Edwards, 1949) noted the effects of raising the herd immunity level through successive annual vaccination campaigns. The vaccination strategy employed benefited considerably from a prior understanding of the epidemiology of the virus, which had maintained epidemic prevalence in the central Irrawaddy River valley but was only occasionally present in the surrounding hill tracts. Vaccination campaigns were deliberately varied in intensity between epidemic zones, which were the initial targets, and the surrounding endemic zones, so that in a given year immunization rates varied from 20 to 88 percent. The effectiveness of raising the overall prevalence of immunity over successive years between 1936 and 1941 is shown in Table 1.

This led Edwards to propose 60 percent immunity within a bovine population as the minimum rate for ensuring that the virus could not maintain itself within a closed population.

The Chinese eradication model, 1950 to 1957: Between 1938 and 1941, more than 1 million Chinese cattle died of rinderpest (Roeder, Taylor and Rweyemamu, 2006); by 1951, an effective live attenuated vaccine was available, based on a modification of Nakamura's lapinized strain. Rinderpest was known to be seasonally epidemic in China, occurring mostly in winter and spring. By adopting an integrated approach that combined epidemiological knowledge with compulsory vaccination and zoosanitary measures and was based on rigorous stamping out, disinfection and surveillance against reintroduction, China became the first country in the modern era to succeed in eradicating rinderpest. The progress and success of its campaign is shown in Table 2. China remained rinderpest-free from 1957, ending vaccination in 1970 and vaccine manufacture in 1980.

The lesson from the Chinese experience was that by combining a zoosanitary approach with vaccination and epidemiological understanding, an eradication programme could be managed for a rapid result.

Indian models, 1956 to 1996: India commenced national rinderpest eradication attempts in 1954, essentially following the Myanmar model of employing vaccination alone rather than in combination with zoosanitary measures, such as slaughter, which was culturally unacceptable, although in the initial phases of the programme, movement control measures were attempted. The veterinary authorities set out to vaccinate 80 percent of the national bovine population (300 million head) within five years, with each state veterinary department being responsible for its own population. In most states, this phase of the programme was broadly very effective (Table 3), but failed to achieve total elimination of the virus. The outcome was that in most Indian states the virus gradually reintroduced itself and, in spite of annual vaccination for the next 30 years, rinderpest remained endemic in southern India (Table 3).

In the face of the vaccination-only model's failure to achieve rinderpest eradication, in 1983 the Government of India commissioned a rinderpest task force report that called for a time-bound programme based on the best epidemiological understanding available. While still relying on vaccination alone, the recast programme moved to the adoption of intensive vaccination in the residual infected areas of southern India over a two-year period (Table 4).

The sudden increase of the proportions of cattle immunized in each vaccination season across the infected districts of southern India was sufficient to eradicate the disease from India in 1996.

Discussion

Zoosanitary controls are a very effective way of controlling and eradicating rinderpest. In the modern era, a combination of vaccination and zoosanitary controls provided the most rapid way to eradicate rinderpest. Vaccination alone can work, but only if allied with measures to prevent residual foci from regaining ground. Intensified vaccination is a useful tool for eliminating such foci.

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TABLE 1

Effect of vaccination on the incidence of rinderpest in Myanmar

Vaccination season	Overall % vaccinated	Epidemiological effects
1936–1937	10	Rinderpest widespread
1937–1938	24	Rinderpest widespread
1938–1939	35	Epidemic rinderpest disappears
1939–1940	48	Rinderpest remains endemic
1940–1941	62	Endemic rinderpest disappears

TABLE 2

Progressive and total reduction in rinderpest incidence in China

Year	Cases of rinderpest	Rinderpest deaths
1949	71 012	52 712
1950	38 515	34 474
1951	52 622	49 331
1952	23 395	22 522
1953	35 045	33 851
1954	29 505	28 812
1955	645	555
1956	120	90
1957 onwards	0	0

TABLE 3

Incidence of rinderpest during the second five-year plan, Andhra Pradesh, India

Year	Rinderpest outbreaks	Rinderpest deaths	Vaccinations (million)	Population vaccinated (%)
1955	No data	No data	3. 11	16
1956	44	251	3. 74	34
1957	128	985	2. 74	48
1958	53	745	3. 31	64
1959	1	4	4. 46	87
1960	0	0	5. 98	117
1964	85	1 254	4. 55	167

TABLE 4

Effect of increasing the proportion of cattle vaccinated in a single season, Coimbatore District, India

Year	Rinderpest outbreaks	Cattle population vaccinated (%)
1992	2	47
1993	6	37
1994	0	137
1995	0	81

VACCINES AND VACCINATION IN RELATION TO THE ERADICATION OF RINDERPEST

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Introduction

From the Middle Ages to the eighteenth century, our ancestors developed curative treatments designed to improve the recovery rate of the individual animal from rinderpest rather than methods designed to control epizootics. In 1893, the Russian scientist Semmer demonstrated that the serum from a recovered animal had both curative and protective powers, and so was born the concept of protecting ahead of an actual infection. In the initial stages, this protection was achieved by introducing immune serum and live virus to create suppressed infection, which nevertheless stimulated the host's immune system into active immunity. This so-called serum virus vaccination was a component of the vaccination campaigns that eliminated rinderpest from Southern Africa during the early twentieth century. Here matters rested until J.T. Edwards, working at the then Imperial, now Indian, Veterinary Research Institute at Mukteswar, India, demonstrated that rinderpest virus could be attenuated through passage in a non-bovine host – namely goats. We now realize that rinderpest virus appears to attenuate during serial passage in almost any host, including cattle, and this realization has spawned a number of live attenuated vaccines, most of which have been used both to control and eventually to eradicate rinderpest.

Description of rinderpest vaccines

The development of most of the live attenuated rinderpest vaccines for use in control and eradication has been described (Taylor, Roeder and Rweyemamu, 2006). In essence, we had the goat attenuated vaccine of Edwards, the rabbit attenuated vaccine of Nakamura, the cell culture attenuated vaccine of Plowright and the Thermovac derivative of Plowright's vaccine with improved keeping qualities. In addition, we have the Russian vaccine derived from an Afghan field strain, K37, attenuated by 70 passages in calf kidney cells – hence known as K37/70. In the English scientific literature, the development and use of this last vaccine is largely unknown, although it is stated that the vaccine was developed for use within the immune zones along the southern borders of the former Soviet Union.

The use of vaccines for rinderpest control

Attenuated vaccines were developed with control rather than eradication in mind. The goat vaccine was easy to produce, but could be pathogenic on occasions, causing mortality in highly susceptible breeds of cattle. Given that cattle races differ in innate susceptibility to rinderpest, and that the lapinized vaccine was much milder but more restricted in availability, it became normal to vaccinate zebu cattle with the goat vaccine and European breeds with lapinized vaccine. Both vaccines stimulated long-lived immunity.

Plowright's cell culture vaccine demonstrated gradations in attenuation at different passage levels, possibly owing to the successive replacement of sub-populations of increasingly low virulence until eventually a product was available that was fully attenuated for all the cattle breeds tested so far. This had the additional advantage of being grown from a substrate that could be expanded to meet production requirements more easily than the vaccines produced from live animals. If well conserved by freeze-drying and distributed within a cold chain, it was also robust; for rinderpest control, it was an ideal product.

The use of vaccines for rinderpest eradication

By 1956, the Indian veterinary services had gained sufficient confidence in their attenuated goat vaccine to embark on a publicly financed, vaccine-based campaign for rinderpest eradication – the National Rinderpest Eradication Programme (Khera, 1979). The programme aimed at systematically vaccinating 80 percent of adult cattle and buffaloes in an initial period of five years. This would be succeeded by a follow-up period lasting until the disease was eradicated. In this follow-up period, the remaining 20 percent of adult animals, plus the annual calf crop (estimated at about 20 percent of the adult population), would be vaccinated.

Each state undertook its own vaccination programme, and up and down the country the success of the initial phase varied considerably. In the northern state of Uttar Pradesh, for example, the main campaign lasted for eight years (1956 to 1964) and follow-up measures for at least another 20 years. Within eight years of starting, 80 percent of the cattle population of Uttar Pradesh had been vaccinated, and the incidence level of outbreaks had fallen dramatically – from more than 1 000 in the first year of the campaign, to single-figure levels by the seventh. In fact, judged by the low number of yearly outbreaks after 1962, there can be little doubt that the endemic status of rinderpest in Uttar Pradesh had been changed irrevocably. It is interesting to note that this was probably accomplished without ever achieving particularly high immunity rates, as even after eight years of work the coverage was only 84 percent, without allowing for failed immunizations or population turnover. In fact, it is quite probable that prevalence rates of between 50 and 60 percent were the best that were achieved, but the outbreak incidence rate plummeted.

Unfortunately, a situation developed across the country in which the use of large amounts of vaccination was having only a limited impact. A repetitive cycle had developed, with annual vaccination campaigns being repeated across the country – a development which we have described as "institutional vaccination". Targets were being met, but the way in which the vaccine was used was not related to the local epidemiology.

Immunosterilization

Immunosterilization is a variant of vaccine campaign in which a whole population of animals is vaccinated within a very short time; it can be dramatically successful. It was applied to all cattle and buffaloes in the dairy colonies around Baghdad and the southern and central governorates of Iraq in 1994. Three campaigns over a three-month period totally eliminated rinderpest infection, which had persisted for several years despite more casual immunization programmes. Similar results were achieved in northern parts of the Republic of Tanzania in 1997/1998, where intense mass vaccination – referred to as immunosterilization (Taylor *et al.,* 2002) – rapidly eliminated an incursion of rinderpest in the Maasai steppe. Most recently, a single round of rinderpest vaccination of the herds belonging to the Murle and Jie peoples of South Sudan eliminated the last reservoir of lineage 1 rinderpest virus in Africa (Roeder, Taylor and Rweyemamu, 2005).

The final successes achieved in India came from the application of immunosterilizing principles. Under a zoning scheme, vaccination was terminated in the north and east of the country, and a concentrated vaccination campaign was carried out in the south – the area identified epidemiologically as still harbouring the virus – with the whole programme embracing the time-bound limits proposed by the OIE Pathway. Immunosterilization relies on developing and maintaining a totally immune population for a short period, a circumstance under which life-long immunity has little relevance.

Conclusions

The recommendations to be drawn from this paper suggest that national and international managers should be aware of what they wish to achieve and should select only vaccines that are easily manufactured, are commensurate with the programme selected, and are integrated within a policy incorporating livestock movement controls and an understanding of the local epidemiology of the condition in question. An effective programme for progressive disease control or eradication must ensure that the quality of the vaccine used is adequately assured by both the manufacturer and the national standards office or equivalent body.

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VACCINE QUALITY CONTROL IN AFRICA

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In 1986, through its TCP projects (TCP/RAF/6766 and 6767), FAO established two regional vaccine quality control and training centres, in Debre Zeit (Ethiopia) and Dakar (Senegal), to guarantee the quality of vaccines used in PARC and to help manufacturers to overcome their problems.

From 1988 to 1993, this initiative was followed by UNDP support (UNDP/RAF/88/050) to the two centres as a single project, which became PANVAC under the responsibility of the then OAU-IBAR and with FAO as the executing agency. In 1993, the two units merged at one site in Debre Zeit (Ethiopia), and PANVAC was assigned the mandates to perform quality control on priority vaccines (rinderpest and CBPP) and promote the adoption of biological standardization and control of veterinary vaccines in Africa. With minor interruptions, PANVAC functioned until March 2004, when it was launched as an AU Regional Centre within the Department of Rural Economy and Agriculture, following the decision of the 67th ordinary session of the then OAU Council of Ministers (Addis Ababa, 23 to 27 February 1998) to elevate PANVAC to the level of an OAU Specialized Agency.

The main achievements of PANVAC are improvement in vaccine production methods and vaccine quality; establishment of a repository of well-characterized reference materials and production of standard operating procedures for vaccine production and quality control in Africa; training of veterinarians and technicians from vaccine producing laboratories; technology transfer for vaccine production; information collection and dissemination; and collaboration with relevant centres in vaccine sciences.

29 June 2010, Padukka - A veterinarian taking a blood sample from a cow for testing to ensure the rinderpest virus has not returned. FAO Project TCP/INT/3204 - Surveillance for accreditation of freedom from Rinderpest. To assist selected countries to obtain rinderpest infection-free status: Inter Regional Kazakhstan, Liberia, Sri Lanka.

EXPERIENCES AND LESSONS LEARNED IN ERADICATING RINDERPEST IN AFRICA: THE JP15 CAMPAIGN

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Summary

With rinderpest now eradicated globally, this review summarizes the difficulties and lessons learned during the JP15 rinderpest campaign. This campaign marked the first time that action was initiated to attempt the control and eventual eradication of rinderpest through international cooperation and overall coordination from one international body. In this paper, the roles played by national governments, international organizations and donor agencies are discussed. Actions that were absolutely essential for the campaign are highlighted, followed by the experience and lessons learned from the campaign, which could be usefully applied to any future mass eradication campaign.

Introduction

Rinderpest existed in Africa as early as the period of the great epizootics. With some notable exceptions, the majority of attempts to control this disease by individual countries operating independently within their own territories were not successful. It was realized that there was an urgent need for all the governments concerned to cooperate and pull their technical and scientific knowledge together to tackle the disease.

The African Rinderpest Bureau was created in 1950 to coordinate this effort. Later, it was agreed that the bureau would serve a more useful purpose if its sphere of activities covered other epizootic diseases in Africa, and in 1952, it became the Inter-African Bureau of Epizootic Diseases. In 1956, its mandate was further broadened to create the Inter-African Bureau for Animal Health (IBAH), which spearheaded the discussion leading to the conception and successful implementation of the famous JP15 Joint Campaign against rinderpest in Africa.

Experiences and lessons learned

Funding and resources: The major donors to JP15 were USAID, the European Commission, FAO, UNDP, the Overseas Development Administration, the German Agency for Technical Cooperation and other bilateral agencies. At that time, it was easier to get donor funds to support such a campaign than it is today; a well-written project document was usually sufficient to release the money required. Donor inputs were generally well-utilized, although there were some cases of mis-use of funds and equipment, mainly at the ministerial level. This led to a recommendation at the Joint FAO/OAU/OIE meeting on Rinderpest Eradication in Africa in November 1981, "that vehicles are only used for the purpose of the rinderpest eradication campaign".

Planning and management: JP15 ran from 1962 to 1976 and was executed in five phases with more than 70 million cattle vaccinated. IBAH and its international coordinators played an essential role in assisting participating countries in planning, financing and implementing the campaign.

During the inception phase, a number of national and international training courses and seminars were undertaken to train those who were to be involved in the campaign. Unfortunately, there were probably too few of these to achieve the levels of training needed, because national governments were reluctant to support them and depended mainly on donor funds and support from international organizations. The major vaccine production laboratories were strengthened to ensure that only high-quality vaccine was used throughout the campaign.

Participating countries appointed national coordinators and vaccination teams. Before field operations began, these national teams extensively educated cattle owners on the importance of rinderpest eradication and the essential follow-up procedures that would need to be implemented. IBAH and its coordinators worked hard to convince policy-makers in national governments to allocate adequate funds for running their campaigns, emphasizing that control of rinderpest would depend on mobilization of national resources and national support to field activities. Success was achieved in some countries, but in others the national coordinators faced a number of constraints, including:

- insufficient financial support from national veterinary services for the performance of their duties, forcing national campaigns to depend on funds from donors for vaccination;
- insufficient vehicles to support the veterinary services, let alone the campaign;
- donations of vehicles and other equipment that proved unsuitable for use under local conditions; at the 1982 rinderpest meeting, FAO, OAU and OIE recommended "that the countries involved be permitted to choose the type of vehicles adapted to their local conditions".

Field operations and immunization: In some campaigns, the immunization of cattle was hindered by:

- improper storage and use of vaccines because of inadequate facilities to transport them over long distances under hot, dry and dusty conditions;
- poor vaccination techniques, resulting in some animals receiving insufficient vaccine to induce immunity;
- some cattle owners failing to produce all their animals for vaccination, despite sensitization to the importance of doing so – one reason was reluctance to bring all their cattle for the three consecutive vaccinations that were then deemed necessary – leaving enzootic foci within the herds of some regions;
- failure to achieve full vaccination coverage in inaccessible parts of some countries or regions due to civil unrest, which also left enzootic foci;
- uncontrolled cattle movements for trade and transhumance, which allowed infected, vaccinated and unvaccinated animals to mix freely;
- field vaccination teams that were insufficiently trained or insufficiently supervised by national and international coordinators;
- limited supplies of the preferred freeze-dried vaccines.

Post-vaccination issues: After the vaccination teams pulled out at the end of the different vaccination phases, national governments were expected to undertake essential follow-up measures. This was particularly important in areas where vaccination coverage was low. However, these measures were often either not carried out or where carried out poorly owing to lack of national financial support from national veterinary services. Routine vaccination of calves was not continued, resulting in herds having little immunity ten years after vaccination campaigns ended.

Where vaccination coverage had been inadequate, rinderpest remained enzootic. Some of these enzootic areas, sometimes known as hot areas, were identified by the follow-up measures, which included disease surveillance. Where remaining foci of disease were found, they were stamped out by concentrated local emergency vaccination campaigns.

Positive lessons: Domestic animal species other than bovine animals played an insignificant role in the epidemiology of rinderpest. Similarly, although cloven-hoofed wild fauna were susceptible to the disease, they were not considered to be epidemiologically significant reservoirs of the virus.

Conclusion

The experiences and lessons gained from JP15 proved invaluable for the planning of its sequel, PARC. In particular, they encouraged more emphasis on strengthening national veterinary services to make them capable of dealing with the important follow-up measures, which donors included in their financing provisions with participating countries.

LESSONS LEARNED FROM THE ERADICATION OF RINDERPEST FOR CONTROLLING OTHER TADS IN AFRICA

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The control and eradication of rinderpest on the African continent demanded huge investments in human and financial resources, which African countries could not mobilize on their own. Donor support was, therefore, secured for various continent-wide programmes, the first being JP15 (1962 to 1976), the second PARC (1986 to 1998), the third PACE (1998 to 2003) and, finally, SERECU (2006 to 2010). These projects were implemented by African countries and coordinated by IBAR, with strong financial support from development partners, especially the EU, and major technical contributions from FAO, OIE and IAEA and from international, regional and national laboratories.

Rinderpest was eradicated from Africa by 2003. Reasons for this success were many, including strong political support from the AU and Member States; reliable veterinary services implementing programmes under the coordination of OAU/AU-IBAR; strong and timely financial support from development partners; involvement of traditional and spiritual leaders; the utilization of CAHWs, which was crucial in the elimination of the disease from civil strife-torn and remote areas of Africa; timely technical inputs, including use of quality vaccines and improved diagnostic tests such as ELISA; and detection of mild rinderpest strains that could have posed a potential danger to the final eradication of the disease. To mitigate potential risks or re-emergence of rinderpest, the following measures must be put in place:

- strengthening of national veterinary services, to guarantee effective national emergency response capacity, including the provision of human and financial resources for immediate action in case of emergence or re-emergence of the disease;

- timely technical inputs, including quality vaccines and improved diagnostic tests such as ELISA, maintenance of strategic vaccine reserves for immediate access in case of re-emergence of the disease, and maintenance of vaccine seed in a credible biosafety bank (such as PANVAC);
- availability of emergency funds that are easily accessible as and when required;
- continuous surveillance of both livestock and wildlife;
- sequestration of strains in African laboratories, or their securing in credible biosafety banks.

In conclusion, over the many years of investment in the control and eradication of rinderpest, lessons were learned that could be recommended for future control and eradication of other TADs in Africa. Included among these lessons are strong political support from AU Member State; AU-IBAR's role in coordinating and harmonizing the implementation of control and eradication campaigns in AU Member States; strong financial support from development partners; reliable national veterinary services; technical support from international partners; utilization of other key stakeholders including CAHWs, who were crucial in the elimination of the disease from inaccessible areas of Africa; the involvement of traditional and spiritual leaders; and a reliable system for ensuring the availability of quality-assured vaccines, supplies and logistics.

EXPÉRIENCE ET ENSEIGNEMENTS À TIRER DE L'ÉRADICATION DE LA PESTE BOVINE

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Rappel historique

L'expérience du PC15: Historiquement, la lutte contre la peste bovine a été à l'origine de la création de la FAO, de l'OIE et de l'actuel Bureau interafricain pour les ressources animales de l'Union africaine ((BIRA-UA), dont le siège est à Nairobi. La mission initialement assignée à ce Bureau consistait en effet à organiser la lutte contre la peste bovine sur le continent africain. Il a donc largement contribué à la mise en place, en 1962, de la campagne interafricaine conjointe de vaccination contre la peste bovine (Programme conjoint N° 15, ou PC15), puis à la coordination des actions de lutte des Services vétérinaires nationaux. Le PC15 a vacciné plus de 70 millions de bovins répartis sur 22 pays et a pu être réalisé grâce à l'effort des États et au concours financier de la CEE. Le lancement de la campagne conjointe, avec ses grands moyens financiers et son organisation, a permis de parachever les mesures locales et de renforcer sensiblement la coopération entre les États dans le domaine de la lutte contre les épizooties.

Toutefois, il faut noter que la stratégie de découpage en plusieurs phases a été un handicap sérieux pour appliquer les mesures sanitaires et contrôler les mouvements des troupeaux entre les pays (Mali et Mauritanie). Cependant, à l'achèvement de la campagne, la peste bovine était retranchée dans deux zones limitées: l'une à l'ouest aux confins du Mali et de la Mauritanie, l'autre à l'est, dans le massif éthiopien.

Ainsi, le PC15 a été l'occasion manquée pour l'Afrique d'en finir avec la peste bovine. Il est vrai qu'il n'avait pas été conçu avec un objectif aussi ambitieux, mais simplement pour renforcer les capacités des services vétérinaires des États auxquels il incombait de maintenir une couverture vaccinale suffisante pour empêcher le redéploiement de l'épizootie. C'était sans compter avec les difficultés budgétaires croissantes de nos pays, aggravées par la crise de l'énergie et l'inflation, qui ont eu des répercussions sur le fonctionnement des services vétérinaires. C'était ignorer également que le recul de la maladie est toujours interprété sous toutes les latitudes comme sa disparition. Dans ces circonstances, les éleveurs ne pouvaient que montrer peu d'empressement à faire vacciner leur bétail.

Enfin, le PC15 n'a pas permis de mettre en place un réseau de surveillance épidémiologique capable d'alerter immédiatement les instances vétérinaires nationales et internationales de la montée des dangers devenue évidente en 1980.

La Campagne panafricaine de lutte contre la peste bovine (PARC): La campagne PARC se justifie par la réapparition dramatique de la peste bovine, cinq années après l'achèvement du PC15 en Afrique de l'Ouest, favorisée par le commerce de bétail provenant de la Mauritanie et du Mali. Depuis 1980, la peste bovine est revenue au premier plan des préoccupations des services vétérinaires de nombreux pays d'Afrique. Chaque fois qu'elle déferle sur une région à l'occasion des mouvements de bétail, les faibles ressources disponibles doivent être mobilisées pour la combattre au détriment de tous les autres programmes, qui doivent être abandonnés. Dès 1981, une campagne d'urgence contre la peste bovine, coordonnée par l'OIE, l'OUA et la FAO a pu être organisée avec un appui financier de la CEE et de la FAO.

Tirant les enseignements du PC15, la FAO, l'OIE et l'OUA définissent clairement que l'objectif doit être l'éradication de la peste bovine, avec la mise au point d'une nouvelle stratégie. Cet objectif est confirmé en 1981 par la Conférence ministérielle de la FAO, qui donne mandat à son Directeur général pour mobiliser les fonds nécessaires, en collaboration avec le Directeur général de l'OIE et le Secrétaire général de l'OUA. Enfin, la douzième Conférence régionale de la FAO pour l'Afrique, réunie à Alger en octobre 1982, réitère la résolution de la Conférence ministérielle invitant à prendre les mesures nécessaires pour la mise en œuvre de la campagne panafricaine et à contribuer à la recherche des moyens de financement. L'évolution des foyers de peste bovine en Afrique de l'Est et au Proche-Orient en 1982 confirme le bien-fondé de cette campagne. En attendant l'appui de la CEE, la FAO octroie une assistance technique de 1981 à 1984 à une vingtaine de pays d'Afrique subsaharienne. Le programme se déroule en trois phases:

- une phase préparatoire d'une durée d'un an;
- une phase de vaccination étalée sur quatre ans, au cours de laquelle la totalité de la population bovine, soit 120 millions de têtes, des 28 pays concernés est vaccinée;
- une phase de consolidation étalée sur six ans commençant dans les pays libérés de la maladie, avant la fin de la deuxième phase. Cette phase chevauché avec le début de PARC.

La phase de consolidation a pour objectif de rechercher activement tous les foyers résiduels qui pourraient subsister après la phase de vaccination. Cette recherche s'appuie sur un *système de surveillance épidémiologique* mis en place dès le début de la campagne, avec la participation active des éleveurs sensibilisés par les médias et avec l'appui d'un bon réseau de laboratoires.

La campagne PARC: une révolution dans les missions des services vétérinaires

Historiquement, la lutte contre les épizooties et les zoonoses a été la mission essentielle des services vétérinaires. Jusqu'en 1980, du fait de l'existence et de la persistance des grandes épizooties que sont la peste bovine et la péripneumonie contagieuse bovines et d'autres maladies communes à l'homme et à l'animal, comme le charbon bactéridien, la rage, etc., l'organisation des services vétérinaires était axée essentiellement sur les *campagnes de vaccination de masse.*

Programmes d'ajustement structurel et services vétérinaires: Au plan financier, depuis la fin des années 70, les budgets des États ont toujours été caractérisés par un déséquilibre entre les dépenses de personnel, de fonctionnement et d'investissement. De 1960 à 1990, on note en outre une baisse constante de la part du budget national allouée à l'élevage. Il faut aussi remarquer que le budget affecté au Service de l'élevage est dérisoire par rapport aux revenus que retire l'État de ce secteur. On ne peut donc pas espérer réhabiliter les services de l'élevage à partir de ses propres recettes.

La Banque mondiale constatait déjà en 1981, dans son programme indicatif d'actions pour le développement accéléré en Afrique au sud du Sahara, "que les fonds destinés à la fourniture des services de base dépassent largement ceux que les gouvernements pourront générer dans les décennies qui viennent. Il est donc hautement improbable que les gouvernements puissent, dans la limite de leurs budgets renforcer les services publics. La privatisation est la seule alternative". L'érosion du service public et l'augmentation des contraintes financières ont donc remis en cause la conduite d'une partie de ses activités par l'État.

Les accords connus sous le nom de "Programme d'ajustement structurel" signés entre les gouvernements et les institutions financières internationales en vue d'atteindre un meilleur équilibre budgétaire ont eu pour conséquences l'arrêt des recrutements dans la fonction publique, l'incitation au départ volontaire et les suppressions d'emploi. En Afrique subsaharienne, lors des discussions avec les bailleurs de fonds et à l'initiative de l'Union Européenne dans le cadre de la préparation du programme PARC, il a été convenu d'instaurer avec les pays concernés un dialogue en vue d'améliorer les prestations vétérinaires, en termes d'efficacité et de pérennité des actions. Ainsi, ce dialogue a concerné: la privatisation de certaines prestations vétérinaires; le recentrage des missions de l'administration vétérinaire et la répartition des activités entre l'État et le secteur privé.

Résultats: Le principal résultat de ce dialogue, entamé depuis 1986, est le changement qualitatif de l'environnement socio-économique du secteur de l'élevage dans tous les pays et notamment dans ceux participant à la campagne PARC et aux programmes contre les autres épizooties, avec comme objectif principal la pérennité des financements des missions dévolues aux services vétérinaires et aux partenaires. Il a fallu conforter les résultats du dialogue, notamment la privatisation, en adoptant et en appliquant des législations en santé animale et santé publique vétérinaire et en les harmonisant au niveau régional. L'un des principaux écueils à surmonter a été la question de la récupération des coûts. En effet, ce recouvrement des coûts était une condition préalable absolument indispensable, sans laquelle toute tentative de privatisation, ou tout effort visant à renforcer l'efficacité des services publics aurait été voué(e) à l'échec.

Les prestations vétérinaires

Politiques de santé animale: La protection sanitaire des troupeaux contre les maladies transfrontières suppose l'existence de politiques nationales définissant les missions et structures d'organisation des services vétérinaires et clarifiant les rôles respectifs des acteurs du secteur de l'élevage. Les services vétérinaires doivent associer les éleveurs et groupements d'éleveurs au processus de surveillance épidémiologique.

A la suite des séminaires et réunions organisés par la FAO et l'OIE, trois catégories ont été proposées pour la répartition des activités entre le secteur public et le secteur privé: activités placées sous la tutelle du service public; activités partagées entre les secteurs public et privé; activités sous la responsabilité du secteur privé. Le réajustement budgétaire, associé au transfert d'une partie des activités au secteur privé, s'accompagne donc d'un recentrage des fonctions attribuées aux services publics. Les différents acteurs de la santé animale deviennent: les vétérinaires privés, les auxiliaires, les associations d'éleveurs et les services vétérinaires d'État. Les prestations vétérinaires sont assurées par chacun de ces acteurs qui participent collectivement aux missions des services vétérinaires.

Les vétérinaires privés: L'installation de vétérinaires privés sur le terrain n'a été possible que grâce à la réunion de plusieurs conditions préalables telles que:

- le choix d'une politique de désengagement de l'État de certaines fonctions
- l'application des textes réglementaires et l'octroi du mandat sanitaire
- la création des ordres nationaux des vétérinaires

Il faut souligner ici, avec force, la nécessaire participation financière de l'État au profit des vétérinaires privés détenteurs du mandat sanitaire, chargés de l'exécution des campagnes de vaccination obligatoire.

Les auxiliaires d'élevage et associations d'éleveurs: La «rentabilité» faible ou nulle, de l'installation d'un vétérinaire dans certaines régions pose le problème de leur encadrement par le secteur privé. Ces régions sont bien sûr les zones arides, peu denses, éloignées ou à vocation saisonnière ou encore insécurisées. Les frais y sont plus élevés alors que la clientèle est plus rare et souvent, les systèmes d'exploitation extensifs et mobiles font que l'on ne dispose pas toujours de la trésorerie nécessaire au moment voulu. A ce niveau, les auxiliaires d'élevage et les associations d'éleveurs doivent prendre le relais.

Il reste nécessaire de définir la relation qui doit s'établir entre ces auxiliaires et les vétérinaires notamment pour l'exécution de certaines tâches déléguées aux vétérinaires titulaires du mandat sanitaire. Il sera alors possible de déterminer la procédure de reconnaissance officielle du rôle des auxiliaires et de leur "homologation".

Réseaux d'épidémiosurveillance: Les mouvements de bétail (commerce, transhumance) constituent la principale voie de propagation des épizooties et, par conséquent, le premier obstacle au contrôle des maladies animales dans la plupart des régions d'Afrique. Il faut souligner cependant que la transhumance reste le seul moyen de rentabiliser l'élevage dans le Sahel, les troupeaux se déplaçant entre maigres pâturages et points d'eau.

Les méthodes de lutte contre les maladies épizootiques sont très variées mais - qu'elles visent à limiter l'impact des principales maladies du bétail sur un territoire national ou à l'échelle d'un continent, à protéger un pays ou une région indemne contre l'introduction d'une nouvelle maladie ou à empêcher l'émergence ou la résurgence d'une maladie - la bonne connaissance de la situation épidémiologique en reste la pierre angulaire. En effet, aucune méthode de prévention ou de contrôle ne peut être efficace si les données descriptives (répartition, prévalence, incidence…) ou les conditions de diffusion (facteurs de contagiosité) ou de persistance (portage et réservoirs domestiques ou sauvages) d'une maladie sont inconnues. Par ailleurs, aucun plan de contrôle de grande envergure ne peut être justifié et mis en place si les coûts économiques et sociaux des maladies et les rapports coûts/avantages des politiques conduites, n'ont pas été évalués comme il convient, notamment sur la base des études épidémiologiques.

La surveillance épidémiologique est la clé de la détection précoce des maladies, qui permet l'alerte rapide dès que le statut sanitaire d'une population animale change. De ce fait, les stratégies de contrôle progressif des maladies animales, notamment transfrontières, doivent reposer sur la surveillance épidémiologique qui doit être partie intégrante de la préparation nationale aux situations d'urgence créées par ces maladies.

La campagne PARC et le programme PACE qui lui a succédé ont eu un rôle prépondérant dans la mise en place du système national de surveillance des maladies et des réseaux d'épidémiosurveillance conformément à la stratégie adoptée lors des discussions pour la mise en œuvre du programme. Il s'agit de garantir, grâce à un système performant de surveillance épidémiologique, la détection précoce des maladies prioritaires et leur notification nationale et internationale, ainsi qu'une réponse rapide aux événements sanitaires majeurs. Cela permet d'appuyer la *réalisation de plans d'urgence nationaux et régionaux* pour faire face aux crises zoosanitaires majeures qui menacent les pays.

Conclusion

Le succès du PARC est réel car, à côté des résultats techniques appréciables liés à la quasi-disparition de la peste bovine du continent, on doit aussi tenir compte des profondes modifications que le programme a entraînées, aussi bien au niveau des États qui, en se désengageant de certaines activités, améliorent l'efficacité des ressources qu'ils emploient, qu'au niveau des bénéficiaires désormais payeurs des services qu'ils demandent.

Un dernier aspect, non le moindre est l'efficacité de la structure de coordination mise en place ainsi que la déconcentration des financements vers les pays bénéficiaires.

Enfin, il faut souligner avec force que le programme PARC prolongé dans sa stratégie par le PACE, a amené les pays africains à partager une vision politique nouvelle des missions et des actions dévolues aux services vétérinaires, conforme aux attentes de la communauté internationale, en termes de sécurité sanitaire des échanges commerciaux de produits animaux et de lutte contre les maladies transfrontalières et zoonotiques.

PERSONAL EXPERIENCE AND LESSONS LEARNED FROM RINDERPEST ERADICATION PROGRAMMES

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Introduction

My personal experience and lessons learned from rinderpest eradication covered almost 40 years, from 1972 to 2010. I started at the Debre Zeit Veterinary Institute, Ethiopia in 1972, producing vaccine for the JP15 vaccination campaign in Ethiopia as a member of the French mission in charge of JP15 activities in four provinces and of technical assistance at the Debre Zeit Veterinary Institute. I was then involved in animal disease diagnostics at the Farcha laboratory, Njamena, Chad from 1976 to 1980, and returned to rinderpest disease diagnosis and control programmes in Côte d'Ivoire, where I was a member of the national PARC team from 1986 to 1992. My contribution to rinderpest eradication became a full-time occupation from 1992 to 1996, when I joined the PARC coordination team in the then OAU, now AU-IBAR, in Nairobi. At that time, I was particularly involved in control programmes in French-speaking Africa and Ethiopia and was in charge of laboratory and general scientific matters, as well as national and regional epidemiology activities. I continued to follow rinderpest eradication programmes when I was director of CIRAD's Animal Production and Veterinary Medicine Department, in Montpellier, France, from 1997 to 2003. In this role, I was responsible for several teams involved in PACE, such as epidemiology, wildlife and vaccine quality, as well as being a member of the PACE Advisory Committee and responsible for research teams working in various programmes (epidemiology, vaccine development) covering other regions of the world. Finally, I was directly involved in the last phases of GREP as Chief of FAO's Animal Health Service.

This experience of JP15, PARC and PACE in Africa, as well as other activities in South Asia, gives me particular insight in summarizing some conclusions on what was done and what were the key elements necessary to achieving global eradication after 40 years of effort.

Lessons learned

Political commitment and regional and international cooperation: Being a transboundary and highly contagious disease, rinderpest could not be controlled and then eradicated without defining, organizing and implementing strong *regional programmes*. This approach complicated the launch of PARC in Africa and made regional work in Asia very difficult; but, in the end, no other method could complete the eradication of rinderpest.

In Africa, *AU-IBAR* committed itself deeply and provided the necessary continental *political support*. This represented a major step towards the organization and implementation of such complex programmes as PARC and PACE.

The *international community* supported these eradication programmes, particularly in Africa and South Asia, where European Community and EU member countries, among many others, participated and contributed financially to the programmes.

The two international organizations, *FAO* and *OIE*, cooperated in many ways from the start of the programmes: joint participation in ad hoc committees, joint conferences and meetings, definition of the OIE Pathway to freedom from rinderpest, OIE accreditation of national freedom from rinderpest, and the final processes leading to the official declaration of rinderpest eradication.

Support from the international community was *long-term*. This was one of the major reasons for success. The eradication of such a disease needs decades of effort, and support for this was missing when JP15 stopped in 1976 after just ten years. Continuation of surveillance linked to alerts, and prompt responses to new outbreaks, such as were seen in PARC and PACE, were simply not possible in JP15 and in many countries, particularly in regions such as the Niger Delta, where rinderpest remained to re-emerge in the 1980s. Fortunately, the new national, regional and international efforts that started in 1982 did not have to stop until the total eradication of the virus almost 30 years later.

Vaccination**:** *Effective vaccine* was a key element in control and eradication, but much effort had to be made to impose the use of a quality-controlled product. The role of PARC in establishing PANVAC in Africa was fundamental in this. PANVAC should remain a pan-African institution in the field of vaccine and biological diagnostic reagents control, to be supported.

The quality of *vaccination campaigns* was monitored through post-vaccination serological surveys. These were done thanks to the establishment of a laboratory network supported by the Joint FAO/IAEA Division in Vienna. Improvement of the quality of serological testing allowed far better control of the efficacy of vaccination campaigns in all PARC member countries.

Blanket or mass vaccinations were indispensable methods for achieving the control and eradication of rinderpest. More targeted programmes could follow later in specific situations, such as in high-risk areas, for example the *cordon sanitaire* in eastern Chad in the 1990s, or in remote and/or insecure regions, such as Afar region of Ethiopia and northern Uganda.

Participatory approaches with the use of CAHWs appeared to be an extremely effective strategy for reaching cattle owners in difficult contexts.

Extensive *communication* activities were developed, particularly during the PARC project, and were a great help in achieving good outbreak declaration and vaccination coverage.

Socio-economic issues were not addressed very deeply, and the issue of cost-recovery, a major strategy of PARC and PACE, was often contentious.

Research, training and capacity building, veterinary services and private-public partnership: *Research* was required at the beginning of PARC to improve understanding of the role of wildlife, develop appropriate serological tests (see above), develop heat-stable vaccine, and design epidemiology and participatory strategies.

Training was the basis of all the programmes' *capacity building* activities, and much was done to good effect in the field of epidemiology, laboratory techniques and communication.

Strong veterinary services were needed to implement all activities devoted to prevention and control programmes, and appropriate laws and regulations had to be prepared and enforced. During PARC, the transfer of certain functions of the public veterinary services to the private sector (the so-called "privatization of veterinary services") was a major component of the programme. The eradication of rinderpest provided an opportunity for developing a private veterinary sector, which until then had been very weak in, if not almost totally absent from, sub-Saharan Africa. A lot was achieved in this field, but more remains to be done. The involvement of private veterinarians as important actors in animal disease prevention and control, in collaboration with public services (in *private-public partnerships*), should continue to be supported.

Post-eradication strategy

Virus sequestration: After the declaration of global rinderpest eradication in 2011, the destruction of rinderpest virus in all laboratories except those few selected to maintain virus and vaccine strain banks for research purposes or possible vaccine production will necessitate international agreement and close monitoring of its implementation. This may not be an easy or short-term task, but it will be indispensable for biosecurity reasons, including the prevention of bioterrorism.

Rinderpest eradication as a model for future eradication programmes: Rinderpest eradication can serve as a *model for future control and eradication programmes,* such as regional and global eradication of PPR and progressive global control of FMD. The lessons learned from rinderpest eradication show that *special conditions* must be fulfilled if control and eradication of highly contagious diseases are to be achieved. Among these conditions are:

- strong political support at the national, regional and international levels;
- long-term support from national, regional and international decision-makers and donors;
- regional and international cooperation, including strong partnership between OIE and FAO;
- strong veterinary services, with appropriate laws and regulations and sufficient government political support to enforce them;
- defined methods and strategies for use in programme implementation, including normative aspects (official internationally recognized control and eradication pathways) and specific laws and regulations;
- strict monitoring of programme implementation;
- strong communication and training components in each programme;
- development of dynamic private-public partnerships and participatory approaches, where appropriate;
- establishment or strengthening of laboratory and epidemiological networks at the national, regional and international levels;
- appropriate research.

LESSONS FROM RINDERPEST ERADICATION: CAN A TECHNOLOGICAL TOOL SOLVE A SOCIO-ECONOMIC PROBLEM?

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This is the story of how the thermo-stable rinderpest vaccine (Thermovax), intended to be a technological fix for animal health service delivery constraints, became a driver for animal health institutional change. Development and testing of the thermo-stable rinderpest vaccine from the Plowright vaccine (Plowright and Ferris, 1962) required about two years to complete (Mariner *et al.,* 1990). The availability of the new vaccine formulation enabled development of brand new strategies for vaccination, including delivery in remote and insecure pastoral areas on foot, by bicycle or using animal transport. However, these opportunities highlighted the need for animal health institutional reform to create new partnerships between livestock producers and public and private professionals so that the skills, knowledge and commitment of all stakeholders could be used to meet their individual and shared goals. This was the real challenge of the thermo-stable vaccine work. It would last more than a decade and involve large numbers of development professionals from diverse backgrounds working in a transdisciplinary manner.

The tangible goal of rinderpest eradication, combined with the opportunities created by the availability of thermo-stable vaccine, drove several institutional innovations. (The term "animal health institution" is being used in the social science sense, to refer to all the organizations and actors that come together to enable animal health services to function, as well as the laws, regulations, customs, values and practices that govern interaction among the participants.) In this paper we will look at three innovations as lessons from rinderpest eradication: community-based vaccination programmes; participatory surveillance systems based on local knowledge; and optimized control strategies that target high-risk communities through combinations of new service delivery models, participatory epidemiology and epidemiological modelling.

The increased flexibility offered by eliminating the need for a cold chain meant that new actors other than veterinarians could become key players in the delivery of vaccination and that the need for expensive fleets of four-wheel-drive transport was greatly reduced. Perhaps naively, advocates for innovative programmes to extend the reach of vaccination into pastoral areas met with unexpected resistance from the veterinary profession. Veterinarians found that the advantages of thermo-stable vaccine threatened some of their core functions and traditional entitlements; they perceived their livelihoods as being in danger. When the situation was analysed from the perspective of the goals and incentives of the diverse stakeholder groups involved, it was realized that win–win scenarios were needed that allowed animal health professionals to fulfil their roles while livestock owners and those committed to rinderpest eradication met their objectives. This was accomplished by advocating for professional regulation of community-based vaccination programmes and ensuring that professionals played key roles in managing CAHWs on the ground (Mariner *et al.,* 1994; Catley *et al.,* 2004; Mariner, 1996).

In the process of establishing community-based animal health programmes, participatory rural appraisal methods were used to conduct needs assessments and understand the knowledge base on which community animal health training programmes would be built. With the advent of community-based rinderpest vaccination programmes, mainstream animal health services and personnel became more directly involved in and exposed to community knowledge. It rapidly became apparent that many communities had very strong traditional knowledge systems that included a practical understanding of the clinical, pathological and epidemiological features of the important diseases that affected their livestock-based livelihoods (Catley, 1999; FAO, 2000). One very relevant realization was that communities often had much better intelligence on the geographic distribution of rinderpest risk and the history of disease in their area than national veterinary services had. Communities could often provide information that, if analysed from a risk-based perspective, led to the detection of active outbreaks of rinderpest (Mariner and Roeder, 2003). This broader recognition of the value of livestock owners' knowledge and the development and application of participatory epidemiology and participatory disease surveillance was an important lesson from the eradication effort, which has been extended to other diseases such as PPR, RVF and HPAI (Jost *et al.,* 2007).

The advent of community-based programmes and participatory epidemiology strengthened awareness of the need for more targeted epidemiological strategies. Early rinderpest control efforts relied largely on mass vaccination, with little regard to patterns of disease transmission, and essentially they targeted the entire national cattle herd. Livestock contact patterns are dictated by social structure and the ethnic relations of communities that own livestock. A minority of experts advocated for targeting resources to high-risk communities, but progress was slow in terms of changing decision-makers' mindsets. In part, this was owing to the sensitivity that surrounds ethnic distinctions in modern societies. High-risk communities were often those that were also politically marginalized, and authorities were reluctant to shift resources away from powerful constituents. As community-based programmes progressed, the heterogeneous nature of the risk of rinderpest transmission that different communities experienced became more widely recognized within rinderpest control circles. Disease control managers began to ask which communities should be prioritized. As part of this analysis, disease modelling studies that combined quantitative epidemiological approaches with expert opinion derived from traditional knowledge was used to prioritize the focus of control programmes (Mariner and Roeder, 2003). In almost all cases in East Africa, the final stages of national eradication programmes were highly targeted and explicitly identified key target communities.

The overarching lesson is that technological innovation can help drive solutions to complex development issues but, in and of itself, is insufficient to solve the animal health problems facing the developing world. For new technology to have an impact, the development community must address the challenging issues of how people work together. This means that we must examine issues from the perspective of each group of stakeholders and visualize how proposed changes would affect their livelihoods and what they value. Beyond this, the power relationships among stakeholder groups also need to be considered. With this knowledge, advocates for change must craft a new vision for how an institution will function, and must communicate that model effectively in a sensitive and concerned manner that recognizes the important contributions of all stakeholders. The net benefit of new vision must be exciting and convincing enough to motivate stakeholders and decision-makers to risk change.

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INTEGRATED COMMUNITY-BASED, PARTICIPATORY AND CONVENTIONAL METHODS FOR RINDERPEST SURVEILLANCE AND ERADICATION – EXPERIENCES FROM SOUTHERN SUDAN

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Introduction

From 1995 to 2000, working for VETAID and UNICEF OLS, I was involved in the establishment of community-based animal health services in southern Sudan to deliver basic animal services and the control of rinderpest through vaccination. From 2001 to 2007, I managed the VSF-Belgium Rinderpest Eradication Project for Southern Sudan, funded first by AU-IBAR PACE and later the European Community, to coordinate and implement rinderpest eradication activities in southern Sudan. The objective was to develop and apply an appropriate system for effective delivery of the national rinderpest eradication strategy in southern Sudan. The main activities were the development of a rinderpest surveillance system in line with OIE requirements; the management of cessation of rinderpest vaccination; the training of veterinarians, animal health auxiliaries (AHAs) and CBAHWs in surveillance and outbreak response, community awareness raising, contingency planning, outbreak investigation and response, and collaboration and coordination with all stakeholders: AU-IBAR PACE, the Government of Sudan, the southern Sudanese authorities, FAO, NGOs and animal health workers.

Lessons learned

Eradication of rinderpest from southern Sudan would not have been possible without heat-stable rinderpest vaccine and community-based animal health workers. From 1993 to 2002, the OLS Livestock Programme used heat-stable rinderpest vaccine that could be carried without cold storage for up to 30 days. With the aim of achieving mass vaccination, teams of CBAHWs were trained to conduct local campaigns with high coverage, even in remote and insecure areas. Systematic sero-monitoring was not conducted, but the blood samples collected indicated average antibody sero-prevalences of 79 percent in vaccinated herds, 57 percent in unvaccinated herds, and 72 percent overall (Jones, 2001).

Rinderpest was eradicated from southern Sudan through the application of targeted vaccination campaigns in key sub-populations, rather than mass vaccination. Vaccination coverage improved as CBAHWs in more areas were trained, but even at its peak in 1994, the proportion of cattle vaccinated annually reached only 31 percent, declining to 10 percent by 2000 (Jones, 2001). This was partly owing to lack of access to some areas, but also because – after initial high demand for rinderpest vaccination when a community-based animal health programme started – livestock owners' priorities changed to other disease problems, and the demand for rinderpest vaccination increased only if there were rumours of rinderpest (Jones, 2001).

It is hypothesized that rinderpest was eradicated from southern Sudan owing to high local coverage in areas where the virus was currently or recently present, resulting in high sero-prevalence sufficient to stop local transmission (Mariner, 2001). Southern Sudan has many cattle sub-populations with varying contact rates among them. Rinderpest was maintained by epidemics circulating through the sub-populations. By achieving high sero-prevalence in key sub-populations, transmission was interrupted, and by the late 1990s, the virus was restricted to a smaller group of sub-populations in Eastern Equatoria and Jonglei regions, where there were a confirmed outbreak in 1998 and a suspected outbreak in 2000 to 2001. A major vaccination campaign in the large pastoralist Murle population, conducted by the Government of Sudan and OLS Northern Sector in 2001, probably resulted in the end of virus circulation in these two regions and the final eradication of rinderpest from southern Sudan.

An appropriate and effective disease surveillance system was established in an under-developed, resource-poor region by promoting the participation of all livestock keepers, CBAHWs, AHAs, veterinarians, NGOs, FAO and local authorities in disease reporting and active surveillance. The community-based animal health programme created an animal health network that linked livestock keepers to a central point. A rinderpest surveillance system was developed by strengthening this network to improve the flow of disease outbreak reports and to deliver information and advice. The surveillance methods were designed to meet OIE requirements and to be appropriate to the animal production systems, the capacity of animal health personnel and the operational context, using local knowledge and experience coupled with technical knowledge and expert advice. Methods included disease outbreak reporting, outbreak investigation, clinical surveillance in cattle camps and markets, participatory disease surveillance in high-risk areas, and random sample sero-surveillance.

Key roles and responsibilities were identified for each stakeholder group, and a programme of training and awareness raising was conducted to ensure that all participants could play their respective roles. CBAHWs were the foundation of the network, providing the essential link to livestock keepers for the rapid reporting of suspected rinderpest cases, even from the most remote and inaccessible communities. AHAs provided basic technical support to CBAHWs, conducted clinical surveillance and were a link to livestock keepers and local leaders. Field veterinarians employed by NGOs, FAO or the government provided technical support, training and supervision of CBAHWs and AHAs, and carried out disease investigations and sero-surveillance.

The Rinderpest Eradication Project team supported the surveillance network with planning, standard procedures, technical information and advice, equipment, communication materials, leadership of disease investigations, participatory disease surveillance and sero-surveillance, basic laboratory diagnosis, and links to reference laboratories and expert advice. There were no functional veterinary laboratories in southern Sudan. To encourage sample collection, outbreak sampling kits and guidelines were provided to all AHAs and field veterinarians. A small laboratory at the Kenyan border provided basic diagnosis of common diseases, but all samples from suspected rinderpest outbreaks had to be transported to regional or world reference laboratories. Obtaining differential diagnosis of rinderpest-like diseases was problematic. The pen-side test for rinderpest was used in the field, but it needed cold storage and careful interpretation. Filter papers were used to collect blood samples for sero-monitoring.

Training, communication and information sharing were priority activities throughout the eradication process, to maintain the interest and motivation of all stakeholders. The project team supported livestock programme coordination meetings and facilitated sessions to provide updates and obtain feedback; facilitated training courses for veterinarians, AHAs and CBAHWs; and conducted community workshops, supported with communication materials such as manuals (VSF-Belgium, 2004), photographs, stories, songs, posters and cloth flip charts (Jones *et al.,* 2002). A reward of USD 500 (increased to USD 1 000 in the final years) was offered for the first report of a confirmed rinderpest case in an epidemic.

A flexible management approach allowed rapid decision-making and resource mobilization based on good knowledge of the local situation. The Rinderpest Eradication Project operated in a constantly changing context, owing to insecurity, extremes of climate, humanitarian crises and continuous political change. It therefore had to be extremely flexible and constantly to adapt to new situations. Decisions had to be made rapidly, and resources mobilized to address constraints and exploit opportunities. This was possible for an NGO such as VSF-Belgium with extensive experience in the area, effective but non-bureaucratic administrative procedures, good relationships with key stakeholders, and links to technical experts who appreciated the difficult field conditions.

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RINDERPEST ERADICATION: THE ROLE OF COMMUNITY-BASED ANIMAL HEALTH WORKERS

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CBAHWs and participatory approaches

In the 1980s, the concept of community participation became widely understood and utilized by development workers. Participation meant that farmers were included as partners at every stage of the planning and implementation of development projects. Communities were no longer seen as passive recipients of external aid; instead, they were helped to make the most of their own abilities and potential. Utilizing this principle and responding to the reduced capacity of government veterinary services to deliver services to rural areas in the early 1990s, several NGOs initiated projects that trained livestock owners to carry out simple veterinary tasks. These trainees became known as CBAHWs. The key criteria that differentiated CBAHWs from other veterinary para-professionals were that they were selected by the community they subsequently worked for, and they were respected, trusted and familiar with the animal husbandry of that community (Catley and Leyland, 2001). This proved to be particularly useful for work with transhumant and nomadic livestock keepers.

CBAHWs and rinderpest eradication

By the early 1990s, PARC had succeeded in controlling rinderpest in West and Central Africa and most of the Horn of Africa. The disease remained endemic in a few remote, conflict-prone areas such as the Afar region of Ethiopia, the Karamoja region of northern Uganda, southern Sudan and Somalia. The latter two areas were in the midst of civil conflict. CBAHWs were first used for rinderpest vaccination and surveillance in the Sudan, Ethiopia and Uganda in the early 1990s. They were not used in Somalia until much later owing to the more top-down and traditional approach of using mobile veterinary teams comprising expatriate and Somali veterinarians.

Veterinary, medical and education services had largely broken down in southern Sudan during the civil war. OLS, a multi-agency relief programme coordinated by UNICEF, began to provide veterinary services after communities refused to have their children vaccinated. People argued that there was no point in vaccinating starving children until the high mortality rates in their cattle had been halted and the milk supply restored. Working in collaboration with numerous NGOs, UNICEF took a participatory approach. A cadre of CBAHWs were trained to report rinderpest and to vaccinate against the disease. The approach was spectacularly successful. The programme achieved a 10.6-fold increase in vaccination coverage following the introduction of community-based systems. From 1993 to 1997, more than 1 million cattle a year were vaccinated, out of an estimated cattle population of 3 to 4 million. As a result, reported outbreaks of rinderpest in southern Sudan decreased from 14 in 1994 to one in 1997 (Jones *et al.,* 1998). Furthermore, serum samples taken from 1995 to 1997 showed a 76 percent sero-positive rate in vaccinated animals. This compares favourably with the vaccination efficiencies of 50 to 80 percent achieved by government veterinary services in PARC Member States (FAO/IAEA, 1992).

Similarly impressive results were achieved in Ethiopia. In 1994, PARC Ethiopia trained 20 CBAHWs in the Afar region and supplied them with rinderpest vaccine. Prior to this, conventional government vaccination campaigns had vaccinated about 20 000 cattle per year in Afar, achieving approximately 60 percent immunity. In 1994/1995, the CBAHWs vaccinated 73 000 cattle and achieved 83 percent immunity. No outbreaks of rinderpest were reported from Afar after November 1995 (Mariner, 1996). In Uganda, beyond delivering the bulk of rinderpest vaccination, CBAHWs were responsible for recognizing and reporting the last known foci of rinderpest in Karamoja, northern Uganda, in 1994.

CBAHWs have not only been a vehicle for effective vaccine delivery, they have also been highly effective for surveillance. Because CBAHWs are local, sometimes even moving with nomadic livestock, they provide front-line outbreak reporting. If government veterinary services are prepared, early reporting makes a tremendous difference to the effectiveness of a response.

By the early 2000s, a network of more than 1 000 CBAHWs superivised by veterinarians was providing clinical services to livestock owners in southern Sudan. These workers were also the main source of clinical disease reports for investigation by professional staff (VSF-Belgium, 2002). In fact, at the height of efforts to detect remaining foci of rinderpest in 2002/2003, southern Sudan routinely carried out more stomatitis-enteritis outbreak investigations per year than any other area in the Horn of Africa. There were 23 investigations in 2002 and 17 in the first half of 2003 – all were negative (VSF-Belgium, 2003).

CBAHWs' impact, sustainability and future role

CBAHWs have proved to have a positive impact on the livelihoods of livestock keepers (Young, 1993; Gleeman, 1999; Dasebu, Escrivao and Oakley, 2003; Ly, 2003; Catley *et al.,* 2004). This is important, as 75 percent of the world's poor reside in rural areas – with 2. 1 billion living on less than USD 2 a day and 880 million on less than USD 1 a day – and most of these people depend on agriculture for their livelihoods (World, Bank, 2008).

To be sustainable, CBAHWs must charge for the clinical services they provide. The typical business model used to keep CBAHWs working has each CBAHW supervised by a veterinarian, or by an animal health technician who is in turn supervised by a veterinarian. This model fits with OIE's guidance on what constitutes a quality veterinary service, as described in the Terrestrial Animal Health Code. It also makes good economic sense, as developing countries still face significant challenges in achieving effective and privatized veterinary services in rural areas (de Haan, 2004). Private practices need to complement public veterinary services, and need to have access to quality drugs and vaccines. The privatization of veterinary services in rural Africa has challenged policy-makers, veterinary associations and donors for the past 25 years (de Haan and Nissen, 1985; Gauthier, Siméon and de Haan, 1999; Umali, Feder and de Haan, 1992). While successful private veterinary practices are now established in areas of high agricultural potential, the expansion of such practices to more marginal areas is poor. In common with many farm animal veterinary practices in industrialized countries, the profitability of emerging veterinary practices in rural areas of Africa is largely determined by the volume of their drug sales, rather than hands-on clinical work. In the developing world, it is often very difficult and expensive to provide access for communities that may be hundreds of kilometres from the nearest urban centre (Kaberia, 2002).

CBAHWs could be the key to providing viable and effective private veterinary services in the rural areas where the majority of poor farmers reside. However, veterinary authorities in many developing countries remain reluctant to allow private veterinarians, including CBAHWs, legally to utilize veterinary para-professionals to boost their business viability; this is despite evidence of the effectiveness of CBAHWs (FAO/IAEA, 1992; Ririmpoi, 2002; Rubyogo *et al.,* 2003). The use of veterinary para-professionals can increase the area that a private practice covers, build links with widely dispersed and often inaccessible clients, increase turnover and make a business profitable (FAO/IAEA, 1992; Leyland, Akabwai and Mutungi, 1998; Coly, Youm and Ly, 2003). Reluctance is based on concerns about quality of service, accuracy of diagnoses, uncontrolled drug distribution, the possibility of drug residues and the quality of advice given (Kelly and Marshak, 2009), all of which are legitimate and can be managed. The concerns are sometimes compounded by fears within the profession of not being able to replace para-veterinarians once they are legally recognized.

There is some evidence that attitudes are slowly changing. In 2006, OIE defined the veterinary para-professional as a person who, for the purposes of the Terrestrial Code, is "authorized by the *veterinary statutory body* to carry out certain designated tasks (dependent upon the category of *veterinary para-professional)* in a country, and delegated to them under the responsibility and direction of a *veterinarian.* The tasks authorized for each category of *veterinary para-professional* should be defined by the *veterinary statutory body* depending on qualifications and training, and according to need". A survey of chief veterinarians, carried out by OIE in 2009, showed generally positive attitudes towards para-professionals and CBAHWs and that these cadres were the preferred options for leveraging and extending the services veterinarians make available to small farmers. Scaling up profitable private practice in rural Africa by using veterinarian-supervised veterinary para-professionals is a win–win–win for rural communities, private veterinarians and State veterinary services wishing to improve the competiveness of national agricultural output through disease control.

Conclusion

Veterinarian-supervised CBAHWs have proved to be effective for disease surveillance, control and eradication. They currently enable veterinarians to establish profitable private practices in rural areas, and have even been used to facilitate conflict resolution and wildlife conservation (Osofsky *et al.,* 2005). There are manuals on how to train CBAHWs, and how to establish community-based veterinary services has been also described (Catley, Blakeway and Leyland, 2002). Most countries with sizeable livestock populations now have national curricula for CBAHWs. Although veterinary authorities are slowly developing supportive policies to allow their use, the challenge for the coming decade will be to establish supporting legislation that allows private veterinarians legally to utilize CBAHWs. Unfortunately, this is a notoriously slow process in developing countries, but some, such as Ethiopia and the Sudan, have already started to lead the way (Catley *et al.,* 2005).

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Discussion

Dr *Raja Rafaqat* noted that the presentation in general, particularly that of T. Leyland, had brought out the important role that CBAHWs have in the control of TADs. Any future international programmes developed for these diseases should consider the very useful roles that can be played by civil society organizations and NGOs, and should incorporate these into their plans.

The post-eradication roadmap

Chaired by Dr Kazuaki Miyagishima
ADG, OIE

POST-ERADICATION ROADMAP: ROLE OF THE FAO/OIE JOINT COMMITTEE AND ACTIVITIES UNDERTAKEN

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Introduction

The global eradication of rinderpest in the field is an outstanding achievement but does not signal the end of the road for rinderpest surveillance and control. A number of important issues remain, and FAO and OIE have established a Joint Committee (JC) for Global Rinderpest Eradication to address these and prepare a suitable roadmap for their completion. Discussing the post-eradication roadmap, two articles in the Terms of Reference for the JC seem to be relevant:

- *Prepare, based on the technical assistance of the OIE Biological Standards Commission, a draft international agreement on the elimination of rinderpest virus (RPV) and of other potentially dangerous biological materials in labs and in other places, and on the choice of a limited number of centres where sample materials can be stored safely for research or vaccine production purposes.* [This issue is sequestration.]
- *Advise OIE and FAO on surveillance and emergency vaccination policy applicable after eradication.*

To address these two issues, the following activities have been undertaken by the JC.

Preparation of guidelines for RPV sequestration

- The GREP Secretariat, the Joint FAO/IAEA Division and the OIE rinderpest ad hoc group, together with invited experts, revised the draft guidelines.
- OIE's Biological Standards Commission endorsed the draft guidelines, with amendments.
- During its second meeting on 14 April 2010, the JC endorsed the guidelines, with amendments.
- The OIE 78th General Session, in May 2010, adopted Resolution 25 on "Destruction, storage and confinement of rinderpest virus-containing material, and other actions required in view of global eradication of rinderpest". The resolution mentioned the draft guidelines and resolved, *inter alia*, to urge members to respond urgently to the questionnaire on rinderpest virus repositories and to destroy rinderpest-containing materials, or assure the storage and use of such materials in a biosecure facility within the country, or assure their transfer to another country in facilities complying with the standards of the OIE manual.

- OIE's relevant commissions (the Scientific, Code and Biological Standards Commissions) were urged to proceed with revisions in the International Animal Health Code and the Manual of Diagnostic Tests and Vaccines, to adapt them to the new environment about to be created in the post-eradication era.

Preparation of a contingency and preparedness plan

A preliminary draft has been prepared and is currently being examined and amended. A mission visited the WHO Smallpox Unit, and the Biological Weapons Convention (BWC) to obtain lessons from their combined experiences.

Other post-eradication topics currently under JC discussion

These include:

- adjustment of OIE Code and Manual chapters;
- inspection of laboratories (mandate required);
- limiting the number of rinderpest virus-holding facilities;
- ensuring continuing diagnostic capacity;
- vaccine and seed banks (and the need for genetically modified vaccine);
- emergency vaccination preparedness;
- monitoring disease management in case of re-emergence;
- the role of research in the post-eradication era;
- veterinary education and training on rinderpest;
- the possible role of the IAEA laboratory;
- the requirement for an international post-eradication advisory and supervision body (for sequestration, biosecurity).

DRAFT DECLARATION AND GUIDELINES FOR POST-ERADICATION STRATEGIES

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Introduction

The final declaration of global eradication has to be prepared by the Office of the Director-General of FAO, in consultation with the Director-General of OIE. The text must be cleared, both legally and politically. The text of the draft resolutions prepared and approved by the OIE General Session held in Paris in May 2010, which has been cleared by FAO, is shown in the following, which may be considered as part of the proposed declaration.

The global declaration of rinderpest eradication

- Acknowledging the efforts made by members of FAO, IAEA and OIE, other international organizations, donors and other partners to eradicate rinderpest;
- considering the conditions made by FAO and OIE towards global freedom of rinderpest;
- noting the conclusions of the Joint FAO/OIE Committee on Global Rinderpest Eradication report submitted in January 2011 to the Director-Generals of FAO and OIE that rinderpest virus ceased to circulate in the field;
- recognizing the importance of reducing the number of existing rinderpest virus stocks by the destruction of the virus in a safe manner and/or the transfer of virus stocks to internationally recognized reference laboratories;
- recognizing the need for the international community and the responsibility of national authorities to take necessary measures to ensure that the world remains free from rinderpest.

the FAO and OIE membership:

- declares that rinderpest, one of the most dreaded animal diseases, has been eradicated from the world;
- expresses its deep gratitude to all nations, organizations and individuals who contributed to the successful eradication of rinderpest;
- jointly take follow-up measures to reduce around the world the number of institutions holding rinderpest virus-containing material other than attenuated vaccines, under approved conditions and according to relevant guidelines.

03 December 2009, Rome - Group Shot - Joint FAO/OIE Committee on global rinderpest eradication.

Guidelines for post-eradication strategies

Establishment of a Post-Eradication Advisory Committee with the following terms of reference.

Under the guidance of the Director-General of OIE and the Chief Veterinary Officer of FAO, the FAO/OIE Post-Eradication Advisory Committee (PEAC) will:

- advise FAO and OIE on the approval (minimum requirements) of facilities for virus strain and vaccine storage in line with the guideline on sequestration of rinderpest virus;
- establish a procedure for the evaluation and approval of requests for research involving rinderpest virus;
- advise FAO/OIE on the establishment of an international contingency plan;
- assist FAO/OIE in the inventory of vaccine strains and virus strains;
- plan and review the periodic inspection of rinderpest virus-containing facilities to ensure that storage is secured and that safe operating conditions are maintained;
- review implementation of the post-eradication strategic plan and report to FAO and OIE;
- ensure, through advising FAO and OIE, that laboratory and epidemiological expertise in rinderpest is not dissipated;
- assist in fundraising for the maintenance of an international reserve of rinderpest vaccines under FAO/OIE control and for implementation of the post-eradication strategic plan;
- assess measures that promote in Member States the widest and most equitable access possible to the outcomes of research, including vaccines and diagnostic tools.

Location: FAO-GREP and OIE-SCAD are to serve as the Secretariat of the committee.

Composition: Rinderpest experts, epidemiologists, virus research experts and biosecurity experts.

Funding: Assess member country support, or each organization to cover the costs for its participants in yearly meetings.

Periodicity: One meeting per year, or in case of need.

The sequestration of all relevant biological materials:

- Laboratories selected by PEAC with containment facilities above level p-3 are to be approved as suitable to hold and handle stocks of rinderpest virus.
- These laboratories should be inspected/audited annually by PEAC or under its supervision.
- All other laboratories should be asked to destroy any stocks of rinderpest virus, or transfer them to an approved laboratory; this should be monitored.
- In case of emergency, the selected laboratories should provide assistance for the diagnosis of rinderpest.
- Research workers who wish to carry out experiments with rinderpest virus that are approved by PEAC should be offered the use of one of the selected laboratories.
- The use of viruses closely related to rinderpest virus should not be allowed in selected laboratories, and such viruses should not be allowed to be stored in deep-freezers that contain rinderpest materials.

- OIE Resolution 25 of 27 May 2010 should be reviewed by FAO, and the final version of the guideline must be prepared.

Other follow-up actions to be considered by FAO and OIE

Annual review of global rinderpest freedom: For ten years, FAO and OIE will review rinderpest-free status annually, through their regular activities, and an annual status report should be announced during the FAO Committee on Agriculture and the OIE General Session in May. In this annual review, it may be appropriate to create a status category for countries that are considered disease-free but have not maintained an adequate surveillance system to detect the disease if present or introduced.

Emergency contingency plans: *Vaccine banks:* Quantities (determined by PEAC) of live attenuated tissue culture vaccine should be produced and stored correctly at selected laboratories. The titre of the stored vaccine should be checked annually by each host laboratory and reported, along with the amount of vaccine maintained, to FAO and OIE via PEAC. Quantities (determined by PEAC) of vaccine seed virus should be stored in the selected laboratories designated by PEAC.

Disease reporting: Any rinderpest-like cases showing high mortality rates must be reported to FAO and OIE for immediate action, if considered necessary.

Contingency plans: A general contingency plan should be prepared by a group of experts nominated by FAO and OIE. The draft plan should be presented during the next meeting of the JC (January 2011). The proposed plan will be reviewed by the FAO/OIE Advisory Committee at its first meeting. The following elements should be included in the contingency plan:

- sources of funding (now and in the future);
- pathways for reporting and information sharing;
- identification of decision-makers and responsibilities;
- actions to be taken in the event of suspected or confirmed outbreaks (including rumour tracking);
- actors responsible for specific actions;
- clear guidance on how national and international authorities will collaborate and coordinate responses within member countries;
- a ready-to-implement response package for vaccination, including vaccines, delivery materials and resources;
- criteria for the selection of response options;
- specification of vaccines to be used and the maintenance of strategic stocks;
- incentives for the maintenance of strategic vaccine stocks;
- strategies and incentives for the maintenance of diagnostic capacity.

Until the contingency plan is finalized and approved by PEAC, FAO and OIE must retain their lists of experts who could serve in case of an emergency.

A book on the history of rinderpest eradication

FAO and OIE will designate editors and prepare a list of chapters to be written by relevant organizations. A list of authors for each chapter should also be prepared by both organizations for discussion during the meeting of the JC in January 2011. Meanwhile, all relevant scientific, operational and administrative data, including photographs, should be catalogued and retained in both FAO and OIE for future reference.

RINDERPEST ERADICATION AND THE BIOLOGICAL WEAPONS CONVENTION: LESSONS LEARNED

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Rinderpest and the Biological Weapons Convention

Rinderpest has been investigated as a biological weapon. There have been cases of preparation for the deliberate instigation of outbreaks of the disease. In addition to interrupting food supplies, such intentionally caused outbreaks were designed to damage both the economy and the socio-political stability of a target. According to the academic literature, during the twentieth century this pathogen was included in State-run biological weapons programmes undertaken by Germany, the United Kingdom, the United States of America, Canada and the Soviet Union (Millett, 2006). Such a geographically diverse and sustained history suggests that the use of rinderpest as a weapon was both feasible and desirable. It may still be.

For those interested in developing such capabilities, there have traditionally been two starting points: to isolate a pathogen directly from nature, or to order one from a culture collection. Recent advances in the biological sciences have added a third path – synthesizing an agent from its genome. The global eradication of rinderpest from nature removes one possible acquisition strategy, making it more difficult to use this agent as a weapon. However, eradicating the disease might affect the desirability of using it as a weapon. Over time, animals can become more vulnerable to the disease, and animal health infrastructure less likely to detect it. Both of these factors could increase the potential damage caused by a release in the future, and may make such a release more attractive to a potential perpetrator.

Building new partnerships

Greater potential impact from the use of rinderpest as a weapon and the shift in possible acquisition pathways will likely increase the focus on efforts to ensure that locations where the virus is retained have suitable safety and security mechanisms. It will be important to reduce the likelihood of the virus escaping accidentally or deliberately and being diverted to malign use. As a result, the security communities, including BWC, have an interest in efforts to eradicate rinderpest and in the sequestration measures that follow. They also have tools and resources that can assist, especially in making sure that remaining stocks of the virus are used safely, securely and solely for beneficial purposes. These overlaps provide important opportunities for building new partnerships between the security and animal health communities.

BWC's Implementation Support Unit (ISU) was pleased to be able to contribute to previous meetings on the eradication of rinderpest organized by FAO and OIE in 2009 and 2010. The ISU is also pleased that representatives of both FAO and OIE have been able to contribute to its own meetings over the past few years. In particular, the ISU is looking forward to contributions to the Meeting of States Parties in December 2010, where additional information on the eradication of rinderpest may be provided to BWC States Parties. The ISU hopes that these partnerships continue to grow and that our organizations are able to work together even more closely in the future.

Opportunities for collaboration

Opportunities for collaboration extend beyond contacts among the policy-making organs of our organizations. We have two community networks, each with its own expertise, resources and geographic distribution. We also have sets of expert laboratory networks working on related but distinct issues. Quite often, different cultures and approaches become barriers to working together. Familiarity, contact and a shared project can often help to overcome such barriers. The eradication and sequestration of diseases such as rinderpest offers such an opportunity. Assistance and cooperation programmes (both under BWC and from outside) have provided training, resources and support to build laboratory biosafety and biosecurity around the globe, by bolstering laboratory capacity in some cases, and even by building tailor-made facilities. Such programmes might also do the same in relation to rinderpest. The security community can bring to the table considerable experience in aspects of stockpile management and international transfer controls, which can help to facilitate efforts to build capacity. Through its last two inter-sessional processes since 2002, BWC has developed a broad range of common understandings across a wide variety of relevant fields that might offer firm foundations for future development through collaborative efforts.

Suggestions for the future

The ISU is grateful for the opportunities offered by its involvement in the eradication of rinderpest. It would like to contribute to similar processes in the future. BWC can offer expertise, best practices, access to partners and engagement with threat reduction communities (and the resources at their disposal). The ISU would be interested in taking an active role in similar efforts in the future, engaging at an earlier stage to increase the opportunities for identifying mutually beneficial partnerships. The ISU would also like to work with the animal health community to find other areas where our interests may overlap.

In 2011, BWC will be holding its five-yearly review conference, where strategic decisions on its work for the following five years will be taken. It will be important that the animal health community is an active contributor to the discussions that will precede this meeting. There is increasing international support for using BWC as a conduit between security and health communities, to deal with disease not only in humans, but also in animals and plants. This would be a good chance to identify specific opportunities for using security resources to bolster the work of animal health, which – in turn – would leave the world a safer and more secure place.

Reference

Millett, P. 2006. Anti-animal Biological Weapons Programs. *In* Mark Wheelis, Lajos Rózsa and Malcolm Dando, eds *Deadly cultures: biological weapons since 1945*, pp. 224–235. Cambridge, Massachusetts, USA, Harvard University Press.

Discussion

Dr Rweyemamu noted that the possible use of rinderpest as a biological weapon, and related matters were weighty issues. With the end of the Cold War there was no longer a need to keep the balance between East and West, but what would be an appropriate balance for selecting the laboratories that can keep and use rinderpest virus or bank vaccine? What assurances could be given to scientists who may need to work with this virus that they would be able to do so? What assurances could be expected in return? Perhaps we need to know what society needs in this regard.

Dr Kiani suggested that from a practical point of view it was worth considering the involvement of vaccinators in the post-eradication strategy.

The Chair, Dr Miyagishima urged that this was the time to look at some of these important issues practically, rather than as theory. The FAO/OIE Joint Committee should take this forward.

Dr Wojchiechowski noted the importance of developing a full and professional record of everything that led to the eradication of rinderpest, including all relevant papers and reports. This record should be accessible to everyone. *Dr Miyagishima,* supported this proposal and suggested that all stories of the eradication be forwarded to the GREP Secretariat. FAO had already promised a number of books and collections of papers.

Dr Domenech reminded the meeting that much had already been well covered and documented, and that all efforts being considered would require long-term support. It would also be important to maintain other aspects of the post-eradication strategy, which could perhaps best be done by integrating it with other disease control schemes. Considering the lessons learned, two important issues were networking and the good quality of vaccine, both of which played key roles in eradication. Another issue was the importance of the private sector; the introduction of "*mandats sanitaire*s" was an important step forward in this respect. There were several good examples where this mechanism made an important contribution to effective vaccination coverage. Any new programme considering other diseases, such as PPR, should include public-private partnerships.

Peste des petits ruminants

Chaired by Dr William P. Taylor

LESSONS LEARNED FROM GREP FOR PPR, AND TOOLS FOR PPR ERADICATION

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Introduction

Stimulated by the success of GREP, it has been proposed that the related virus of PPR is another candidate for global eradication. FAO funded a consultancy in 2010 to examine this issue; the report of that consultation as well as information provided by FAO (FAO, 2010) provided the backdrop to this paper. In the 1980s, the proponents of GREP acted on the understanding that rinderpest virus had certain attributes that made eradication feasible: it existed as a single serotype, so a single vaccine could stimulate immunity against all known field viruses; exposure to wild-type or vaccine viruses elicited life-long immunity; there was no carrier state; a safe, efficacious and affordable vaccine was available; and there were no known reservoirs of persistent infection other than cattle.

The same can be said of PPR virus; most of the tools needed are available, although requiring some refinement. However, we urge caution before enthusiastically espousing the cause of global PPR eradication as a goal from the outset of any coordinated action. In reality, rinderpest was eradicated only once there was an effective coordinating body and advances had been made in rinderpest epidemiology, which made it possible to focus resources on key areas. During GREP, experience and research led to an understanding of the global distribution of rinderpest and that the disease's occurrence could be explained by persistence of the virus in stable reservoirs of infection within extensive livestock systems – primarily in pastoral areas of Africa – and within vibrant livestock trading systems linked to dairy production systems in Asia. In the case of PPR, the global distribution of the disease, although expanding relentlessly, is fairly well-known, but many aspects of the disease's epidemiology are less clear. Most important, the sustained chains of transmission in endemic areas are not well understood. Research in Oman by Taylor, Busaidy and Barrett (1990) raised the possibility that PPR could be maintained within urban goat populations, with periodic epidemic extension into rural areas as populations of susceptible young stock build up, akin to the case of human measles. Alternatively, the virus could be cycling persistently in low-density but extensive rural small ruminant populations, much as rinderpest did in eastern African pastoral cattle, until recently. If the former applied, focusing vaccination on urban small ruminants could bring rewards in rapid disruption of virus transmission chains and reduced costs of vaccine delivery. Clearly, understanding this and other epidemiological issues, such as viral propagation rates, the decay rate of maternal antibodies and age-specific infection and case fatality rates, must be an early priority for any programme.

There are many practical issues that will need to be addressed before significant progress can be assured. The most challenging of these relate to the delivery of vaccines to small ruminants at sufficient intensity to generate herd immunity that is able to exclude introduced infection. It was difficult enough to generate such herd immunity for rinderpest, and we must take note of the fact that small ruminant numbers are far greater than those of cattle and buffaloes. Of the approximately 1 050 million sheep and goats in developing countries, 53 percent (556 million) are in Asia and 33 percent (346 million) in Africa. Table 1 gives some illustrative comparisons of large and small ruminant populations in a number of countries severely affected by rinderpest into the late twentieth century and where PPR is currently a major problem.

These very rough figures suggest that suppression of PPR would need to target more than twice the number of animals that was necessary for rinderpest control, and these figures do not take into consideration the much higher natural replacement rates of sheep and goats than cattle. To achieve effective coverage of such a population, a far more dynamic approach than that of annual, pulsed official vaccination campaigns is needed. While suppressing infection to a degree, these proved incapable of eliminating rinderpest reservoirs and are unlikely to fare any better for PPR.

However, these comments should not be taken as precluding action against PPR. It is proposed that a strategic plan for progressive control should be elaborated, building on lessons learned from GREP that relate to a mix of technical, organizational and political issues (Roeder and Rich, 2009). The technical issues relating to such matters as the formulation of a thermo-stable and marked vaccine, small size vaccine vials, rapid field diagnostic tests,

TABLE 1
Large and small ruminant populations in countries that were formerly affected by rinderpest and where PPR is endemic

Country	Sheep and goats (*million*)	Cattle and buffaloes (*million*)
Pakistan	81.0	57.0
Afghanistan	16.0	3.7
Jordan	0.81	0.05
Saudi Arabia	11.9	0.3
Islamic Republic of Iran	80.0	8.5
Ethiopia	47.0	30.0
Eritrea	7.1	2.0
Sudan	91.1	39.8
Kenya	23.3	14.8
Total	**358.2**	**156.2**
Ratio of small to large ruminants	2.3:1	

improved laboratory diagnostic tests, clear epidemiological definition and socio-economic appraisals should all be relatively easy to address. The procedural and organizational issues, as well as the definition of strategic options, are likely to be the most challenging. It is essential not to think of the process as a short campaign; rather, it should be conceived as a long-term activity over at least 25 years. Initially, the concept is of systematic suppression of disease circulation through regionally coordinated programmes, leading to virus sequestration within areas of endemic virus maintenance. As with rinderpest, an epidemiology-driven and adaptively managed programme is most likely to succeed.

Basic precepts

It is unrealistic to expect that all the costs of control will necessarily be borne by countries' governments and/or the international community. Official government veterinary services need to be responsible for maintaining an enabling environment for PPR control, disease surveillance, outbreak investigation and diagnostic confirmation, emergency outbreak control actions, promotion of control options, and applied research to refine control strategies. However, vaccine delivery for progressive PPR control should be considered within the systematic provision of services, with the State encouraging private veterinary practitioners to provide such services to farmers and allowing community-based health delivery systems for small ruminants. The emphasis should be on disease avoidance through routine regular preventive vaccination as part of health management for small ruminants, rather than on the emergency control of disease outbreaks. Elements of this could be:

- vaccination against PPR, sheep and goat pox, and contagious caprine pleuropneumonia (CCPP);
- helminth control, especially of *Haemonchus contortus* and *Dictyocaulus filarial,* through the promotion of and support for strategic anthelminthic dosing regimes;
- tick and mange control;
- attention to nutritional deficiencies, such as copper deficiency in the African Rift Valley;
- clinical services.

As was the case for rinderpest and CBPP, in some regions it will be appropriate, even highly desirable, for a programme for the progressive control of PPR to be linked to control of another disease, such as sheep and goat pox, to convince livestock owners of the value of belonging to the programme. In the minds of livestock owners, losses from diseases other than PPR could easily discredit a control programme for PPR alone.

Necessary research to be commissioned will be indicated by a gap analysis and must be pragmatic. It will include socio-economic analysis; epidemiological studies: disease transmission chains, identification of reservoirs and disease modelling, for epidemiological insights; viral behaviour and virulence determinants; diagnostic and surveillance methodology; molecular epidemiology; filter paper sampling for serology; rapid field tests; DIVA tests; and vaccines (marked, thermo-stable and recombinant).

FAO was mandated by the agriculture ministers of its member countries to take on the coordination of GREP from 1993 and provided the basic funding necessary for the GREP Secretariat to function. Hosting international fora for information exchange (e.g., FAO technical and expert consultations), providing support to individual countries, progress monitoring and strategy development, and supporting a World Reference Laboratory for Rinderpest were particularly valuable activities. Building on earlier progress, and given the support of donors such as the European Commission, success in eradication came quickly, illustrating the value of an expert technical coordinating body. FAO, as the most – and arguably the only – appropriate institution, should again take the initiative in establishing a coordination mechanism for PPR control, with an FAO/OIE Secretariat based at FAO Headquarters, the FAO/IAEA Joint Division, FAO's decentralized offices and FAO/OIE regional animal health centres. Among its earliest actions should be to guide the conducting of a gap analysis of epidemiological understanding and tools for PPR control, to define control options, and to produce a research plan.

Elements of a PPR control programme

Much more thought needs to go into developing the concept, but a global programme can be envisaged as having three phases.

Phase 1

Initiation of control programmes where an enabling environment exists, and preparation for more intensive control: It will be necessary to build international support for a coordinated intervention on PPR; this will require socio-economic analysis of the impact of the disease and its control. One early activity should be to convene a global meeting of stakeholders, to garner and gauge support, explain/refine concepts, and develop a work plan based on regional priorities. The meeting needs to comprise technical experts from a broad range of stakeholders: FAO Headquarters and regional offices/animal health centres, and the FAO/IAEA Joint Division; OIE; donors such as the European Commission, USAID, DFID, SIDA and the Bill and Melinda Gates Foundation; NGOs such as FARM Africa, VSF-Belgium and GALVMed; regional organizations such as AU-IBAR, SAARC and the Global Cooperate Challenge Livestock Committee; and key countries such as India, Pakistan, Saudi Arabia, Yemen, Jordan, Ethiopia, Kenya, Mali, Egypt, Turkey and the Islamic Republic of Iran. The meeting must also identify and agree on the roles of major stakeholders and strategic linkages – the FAO/IAEA Joint Division, reference laboratories and collaborating centres, ILRI, etc.

The coordination procedure must also include the convening of regular coordination meetings: global meetings for periodically assessing progress and identifying constraints, and regional meetings for assessing progress and needs, as well as informing and sustaining political support for interventions.

Initially, only relatively crude guidelines will be available, and the lack of socio-economic data might make it difficult to persuade national funding bodies and donors of the value of a systematic approach to PPR control. However, some countries, already convinced by their experience of the disease and its impact, will wish to be involved from the start. This situation should not be a matter of concern; it is expected that the generation of socio-economic impact data combined with reports of the advantages to be gained from systematic control will rapidly bring most countries into active engagement.

During this first phase it is necessary to initiate a number of activities to prepare for progressive control:

- Develop guidelines for a strategic and systematic approach to PPR control, and plan implementation using a holistic approach to vaccine delivery; produce socio-economic data; and build awareness, expertise and commitment. Among other issues, early decisions will be needed on:
  - an appropriate regionalization strategy, matching ecological considerations with regional economic groupings, such as the Near East (Jordan, Lebanon, the Syrian Arab Republic and Iraq), the Arabian Peninsula (Saudi Arabia, Yemen, Oman, Kuwait, Bahrain and Qatar) and Central Asia (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan and the Islamic Republic of Iran);
  - a pathway for accreditation of PPR freedom and, later, the eventual declaration of PPR eradication (if this becomes the intention).
- Develop supporting manuals that include:
  - clinical recognition and epidemiology;
  - performance of laboratory tests;
  - vaccine production and quality control standards;
  - field control.
- Ensure ongoing applied research.
- Organize diagnostic networks through the FAO/IAEA Joint Division, working with FAO/OIE reference laboratories and collaborating centres; establish and oversee working groups on:
  - research needs (gap analysis) and progress;
  - epidemiological needs (gap analysis) and progress;
  - control strategy and progress;
  - practical issues associated with key trade routes: India, Nepal, Bangladesh, China; the Sudan, Eritrea, Ethiopia, Kenya, Somalia, Yemen, Oman, Saudi Arabia; etc.

Phase 2

Systematic suppression of disease circulation and sequestration within areas of endemic virus maintenance: The process of developing the tools for effective disease control will be continued, and the increased understanding and experience gained will then be used to develop and implement regional plans for progressive control. In particular, a more focused approach to eliminating PPR will be followed, leading – in time – to area-wide clearance of infection.

Phase 3

An eventual eradication phase: Once the disease is largely contained within a relatively small number of persistent reservoirs, the coordinating body will, at the appropriate time and based on an analysis of progress, convene a global meeting to consider if there is scope for considering PPR as a target for global eradication. At this stage, the funding of campaign-type interventions to bring about the rapid demise of PPR could be considered a public good.

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POTENTIAL IMPLICATIONS OF RINDERPEST ERADICATION FOR PESTE DES PETITS RUMINANTS

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Introduction

PPR is an increasingly important viral disease of livestock that predominantly infects small ruminants. It is now maintained in enzootic transmission in a large belt across Africa, the Near East and Asia, putting 1 billion small ruminants at risk annually. Sheep and goats widely distributed in the world have been shown to play a major role in rural economics, as they can be managed under many production systems and represent the principal source of income for many poor families.

PPR is a febrile illness that in severe cases causes mucopurulent ocular and nasal discharges, harsh erosion of the mucosa and, in fatal infections, death caused by bronchopneumonia or acute diarrhoea and severe dehydration. The virus is highly contagious and easily transmitted by direct contact between the secretions and excretions of infected and healthy animals. Symptoms are often confused with and exacerbated by secondary infections, making PPR a difficult disease to characterize, diagnose and treat.

Recent developments

There are convincing observations and reports showing the ability of PPRV to cross the species barrier. Indeed, PPRV can infect animal species other than small ruminants, and dromedaries and cattle with PPRV have been identified in pathological samples. However, the difference between dromedaries and cattle is that, while infection in the latter is subclinical, in dromedaries, a respiratory syndrome is the prominent characteristic of the disease, similar to first reports in Ethiopia in 1995/1996 (Roger *et al.,* 2001).

Since the late 1970s, sub-Saharan Africa, then the Near East and Asia, increasingly experienced severe epidemics. The process of expansion into new, uninfected territories continued and, particularly from 2005 to 2010, a dramatic ecological expansion of the disease occurred. In Africa, PPR moved towards the southeast, crossed the equator and affected a belt of countries from the Gabon to Somalia, the most recent being the United Republic of Tanzania in 2008. Another noticeable event during 2008 was the incursion of PPR into Morocco.

The current global extension of PPR may be a consequence of rinderpest control and eradication. Indeed, a striking parallel can be made between the progress of PPR in the world and the progress of GREP. When RPV was endemic in Africa, Asia and the Near East, many small ruminants were probably infected sub-clinically and protected against both diseases as a result of cross-reacting immunity. With the eradication of rinderpest, this cross-immunity no longer exists, putting small ruminants at risk of PPR. Emergence is also favoured by the increase in the small ruminant population in general, owing to the sharp increase in the human population and the growing demand for red meat.

In addition, it is noted that expansion of PPR is linked to change in the current distribution of the genotypes of the virus. Molecular epidemiology has genetically divided PPR virus into four lineages: three historically settled in Africa, and one – lineage IV – confined to Asia. However, recent material submitted to the world reference laboratories at IAH Pirbright (United Kingdom) and CIRAD indicates that the disease's expansion across the world is linked to incursions of foreign genotypes into historically defined areas, for example, lineage IV into Africa. Data collected over the last decade illustrate the wide incursion of lineage IV from the Near East into the Sudan and neighbouring countries, including the Central African Republic and Cameroon. The same lineage was found in Morocco in 2008. Thus, in less than two decades, Asiatic lineage IV was shown to leave its "birthplace" to occupy a core region of the African continent stretching from the Red Sea through to the Gulf of Guinea and the Mediterranean Sea. Simultaneously, the distribution and prevalence of indigenous lineage III has dramatically reduced in the Sudan.

Of importance is the discovery in the Sudan of lineage IV causing high mortality in dromedaries, while outbreaks in small ruminants are more common. This confirms the importance of PPR in dromedaries in the Horn of Africa, with mortalities reported on several occasions in eastern Sudan (2004) northern Sudan (2005) and the Blue Nile area (2007). It is important to note that phylogenetically identical virus was also recovered from sick sheep and goats in a large zone encompassing camel-grazing areas. Unlike those in dromedaries, PPR outbreaks in cattle have not been linked to mortality. It would seem that young cattle are more receptive to PPRV, but persistent cycles of infection are not established, and the species seems to have suffered no epidemiological impact.

With rinderpest eradicated, it could be hypothesized that cattle may be at risk if the virus adapts to transmission within this species in the near future. However, this hypothesis can be largely ruled out by considering molecular clock predictions based on the evolutionary rate of negative stranded viruses (about 6.0×10^4 mutations/site/year). These can be used to determine the time needed for a virus to emerge in another species and adapt to its new host. The example published (Furuse, Suzuki and Oshitani, 2010) is that of measles virus, which emerged from RPV. This did not occur at the time of cattle's domestication, when cattle and humans began to live in close proximity, but it is estimated to have occurred perhaps as late as the eleventh or twelfth centuries. This finding is unexpected because measles virus was previously considered to have evolved in the prehistoric age. Therefore, if the time needed for a morbillivirus to adapt and emerge in another species is more than 9 000 years, it is unlikely that PPRV will adapt rapidly to cattle in the near future.

Conclusion

There is evidence that the eradication of rinderpest has brought PPR into the limelight, that populations of the most economically vulnerable people are implicated, and that small farmers in arid and semi-arid areas may herd together several species receptive to PPR, particularly small ruminants and dromedaries. Regarding this last point, work is needed to evaluate the roles of the different species implicated in PPR's epidemiology and to test the consequences of control programmes, especially partial or total vaccination. It will be important to evaluate the need to include dromedaries in vaccination campaigns. The lessons learned from GREP, and the availability of tools already adapted to PPR allow the development of control strategies that enhance the prospect of PPR eradication.

References

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CONTROL AND ERADICATION OF PESTE DES PETITS RUMINANTS IN NIGERIA

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Introduction

PPR is a severe, fast-spreading disease of domesticated and some wild small ruminants. It is characterized by sudden onset of depression, fever, ocular-nasal discharges, stomatitis, pneumonia, diarrhoea and death. The disease was first reported in Côte d'Ivoire in 1942 and, because it resembled rinderpest (*peste bovine,* cattle plague), was given the name "peste des petits ruminants" (small ruminant plague). In subsequent years, the disease came to be recognized in Benin, Senegal, Nigeria, Ghana and eventually throughout sub-Saharan west and central Africa. The disease has subsequently been confirmed in a number of other African countries, including Ethiopia, the Sudan, Egypt and the Central African Republic, as well as many in the Near East and central and south Asia.

Serological studies in both northern and southern Nigeria showed infection rates of 53 percent in goats and 43 percent in sheep. These figures suggest that PPRV infection is more widespread than overt disease in the country. Although the precise socio-economic impact of PPR in Nigeria has not been quantified, the ease with which it spreads and its morbidity and mortality patterns indicate that the disease causes very significant production losses, constitutes a threat to food security, and mitigates against income generation for the rural poor, including women heads of households and widows.

The situation regarding PPR control in Nigeria

Most staff of both state and federal animal health services are sufficiently familiar with the clinical and pathological features of PPR to ensure that early diagnosis of any outbreak should not pose a major problem. The clinico-pathological features and diagnosis of PPR are adequately covered in veterinary undergraduate curricula and in continuing education programmes and special training workshops to update older veterinarians and to familiarize those trained abroad with the essential features of major TADs, including PPR, and appropriate control measures.

A good national animal disease surveillance and information system is essential for successful control of PPR. In Nigeria, two complementary programmes –PACE and the National Special Programme for Food Security (NSPFS) – established a National Network for Animal Disease Surveillance and Early Warning and strengthened zonal and state epidemiological units, which involve clusters of the country's states. The programmes also increased the national laboratories' capacity for animal disease diagnosis and provided strong linkages to regional and world reference laboratories for PPR, as well as the capacity for PPR vaccine production, storage, quality control and speedy distribution when needed. Under PACE and the NFPFS, workshops on TADs, including PPR, were carried out for livestock farmers and expanded to involve private veterinarians, veterinary auxiliaries and CAHWs.

A number of epidemiological and other factors have positive or negative impacts on the strategies to be adopted and the ease of control and/or eradication of PPR. For example, all PPRV isolates are antigenically homologous, there is solid immunity following infection or disease, and there is no carrier status following infection and recovery from the disease. The virus is labile and susceptible to environmental conditions, so formites are unlikely to be important means of transmission except, perhaps, for a short period after being contaminated. In Nigeria, sheep and goats are the natural hosts of the virus, and although the role of wildlife in the transmission and perpetuation of PPR has not been quantified and verified, wildlife would seem to be unimportant when the disease is controlled in domestic small ruminants. Epidemiological surveillance of PPR in wildlife is desirable and would become imperative when considering an eradication phase for PPR.

Both antibody and antigen detection tests that are simple, specific and sensitive are available. Heat-stable vaccines are available and should eventually be in small-dose ampoules that can be administered by livestock farmers and CAHWs. However, animal movement control is very difficult to implement, given the prevalent informal transboundary grazing of and trading in livestock by farmers and owners.

Strategy for progressive control and eradication

It is my opinion that progressive control of PPR in Nigeria should consist of comprehensive and sustained mass vaccination of sheep and goats of all ages for three years, followed by continued vaccination of only young kids and lambs at about five to six months of age. In the face of any outbreak during this period, ring vaccination should be carried out, accompanied by the safe disposal of carcasses, and decontamination. To reduce contagion, attempts should be made to enlist the cooperation of owners of affected animals, to restrict the movement of small ruminants and discourage the selling of sick animals and the redistribution of in-contact animals to relations and friends. For smallholder village flocks, CAHWs and small ruminant owners should be involved in vaccinations. Vaccination should be carried out by animal disease surveillance agents and animal health service providers, as established under PACE and the NSPFS – livestock farmers and trained community vaccinators. To ensure optimum results, vaccinators should be selected from the people who raise small ruminants, such as those currently benefiting from the small ruminant aspect of the NSPFS, including women.

Vaccination imperatives: It is preferable to use homologous, heat-stable PPR vaccine, and this should be produced in small-dose ampoules by the National Veterinary Research Institute at Vom. Currently, it is anticipated that the vaccines will be produced in 20-dose ampoules and cost about 20 naira (NGN) per dose. Well-planned public awareness programmes for livestock owners and the general public would assure farmers' confidence in the control measures.

The cost of PPR vaccination should be shared between the Federal Government and the livestock farmers/owners and built into ongoing efforts to privatize veterinary practice. Farmers would be expected to pay for the vaccines. In most cases, farmers place higher value on vaccines if they have to pay for them, at the full price or with a subsidy, and the funds realized should be used to ensure sustainability. As a single inoculation of the vaccine is expected to produce solid and life-long immunity, the benefit of vaccination is likely to become apparent to farmers as early as the second year of the programme. In addition, as the CAHWs, community inoculators, animal disease surveillance agents, animal health services providers and private veterinarians would also be involved in other animal health services, such as active disease surveillance of other TADs and internal, and external parasite control, the government may wish to share the labour and other professional costs with the farmers (Njeumi, personal communication). This would help to sustain private veterinary practice.

One foreseen problem is the identification of vaccinated sheep and goats. Livestock vaccination cards, which should be endorsed by vaccinators, could be provided to animal owners. Livestock farmers' production of such cards could then be used to attract a subsidy for vaccine cost in subsequent interventions.

Vaccination campaigns should commence one to two months before the expected period for the highest occurrence of PPR outbreaks, and vaccination of animals showing clinical signs of PPR should be avoided. To the extent possible, vaccinations should not interfere with the primary occupation of livestock owners, such as trading or crop farming. Maximum use should be made of school holiday periods, when children are more likely to be available to help, as their youthful curiosity and interest in watching vaccinations could assist in spreading the message through the community.

Sero-monitoring and active disease surveillance should be carried out during the third and fifth years of the vaccination campaign. If the results of PPR surveillance indicate very low levels of disease, if the national early warning and early reaction capabilities have become more efficient, and if adequate funds are available and the threat of reintroduction from neighbouring countries has become minimal, the country may review PPR control and adopt a different option. Despite mass vaccination campaigns for the progressive control of PPR, an outbreak of the disease should be regarded as a TAD emergency.

Overall policy for PPR control in Nigeria: Given the evidence of widespread PPR infection in Nigeria, the difficulties with quarantine and animal movement control, the constant risk of repetitive introduction of the disease from neighbouring countries, and the need for further enhancement of Nigeria's early warning, early reaction and laboratory diagnostic capacity and capability, the overall policy for PPR control in Nigeria should be:

- mass vaccination of sheep and goats using heat-stable homologous PPR vaccine for three years, and thereafter annual vaccination of only lambs and kids of five to six months of age;

- sero-monitoring of PPR vaccination during the third and fifth years of the vaccination campaign;
- animal movement restrictions, safe disposal of carcasses, decontamination and ring vaccination in the event of PPR;
- review of the status of PPR and the strategy for its control in Nigeria after five years.

PESTE DES PETITS RUMINANTS IN INDIA: APPROACHES TO CONTROL AND ERADICATION

Malleshappa Rajasekhar
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The epidemiology of PPR in India: considerations

To survive, PPRV requires a constant supply of susceptible hosts, and India has a very large supply. The country has the world's second and third largest populations of goats (124 million) and sheep (61 million), respectively. In addition, the rapid population turnover of small ruminants depletes the immune animals and adds susceptible ones to the population, making it congenial to the virus's survival.

Although there is retrospective evidence that PPR may have been present in India for more than 60 years (Taylor *et al.,* 2002), it was first detected in Tamil Nadu in 1987, in Andra Pradesh in 1989, and throughout the country in the 1990s. It has affected most of India's 29 states and is "guesstimated" to have killed up to 50 percent of the country's sheep and goats in the intervening period. The epidemiology of the disease has been little studied and is poorly understood in most states. There is some evidence of low contagiousness, which may aid virus persistence. Fortunately, vaccine has been available and widely used for the past ten years, and the incidence of the disease appears to have stabilized and may even be reducing. Disease reports suggest that disease is more apparent in very young stock, possibly because the virus is restricted to this age group, with older animals having increasing immunity. There is a need for a national control policy for PPR, and an epidemiologically based strategy would be the right approach to this.

Observations on the epidemiology of PPR in Andra Pradesh

Recently we have begun studying the epidemiology of PPR in the state of Andhra Pradesh. The prevalence of reported outbreaks of PPR varies considerably among districts in the state – from nearly 300 a year in the most affected to just over ten in the least. We have also been able to study and summarize reports for the past seven years, and these show a definite peak of outbreaks in the spring months, February to May, leading up to the extreme heat of summer and the monsoon.

Proposed control of PPR in Andhra Pradesh

We have decided to make a concerted effort to control PPR in Andhra Pradesh. Using preliminary epidemiological information, we will start by concentrating on the ten most affected districts, where more than 80 percent of the outbreaks in Andhra Pradesh occur. Raising and maintaining high immunity levels in such large and rapidly replacing herds and flocks is almost certainly unsustainable over the long term. The tactic we will use is an intensive pulse of vaccination to sanitize the population effectively by immediately "freezing" virus transmission, thereby eliminating the source of virus for most outbreaks. This will also have the effect of ensuring that all young stock have sufficient maternal immunity to withstand challenge before they are vaccinated. The aim is to remove the virus from the populations rather than to develop herd immunity that protects some, but not all, of the population. The newly immune population will then be protected by routine vaccination along border areas and areas of high risk, such as migratory and trade routes and markets. This approach will benefit from a simultaneous national effort to eliminate virus persistence.

The control policy in the remaining districts of Andhra Pradesh will have two components: mandatory vaccination in villages and areas with a history of disease; and no routine vaccination in the areas where PPR is absent or rare. In unvaccinated areas, there will be good disease searching and reporting, supported by efficient control and elimination of outbreaks through ring vaccination and zoosanitary precautions. We are prepared to allow cryptic virus to surface, allowing us to see it and eliminate it rather than letting it lurk in the population. Freedom in these areas will be regularly assessed through sero-surveillance.

After three to five years of vaccination in high-risk areas, and surveillance and elimination in lower-risk ones, we hope to be in a position to assess the success of the strategy and consider moving to an eradication phase.

Proposed eradication of PPR

Learning from our success with rinderpest, we do not want to be drawn into eternal mass vaccination. When we can see that the control programme outlined in the previous section has proved effective in bringing down the population's disease burden, we will move into an eradication programme. In particular, we will look to identify disease-free areas and areas where only a minimal number of sporadic outbreaks occur, which are rapidly eliminated. However, Andhra Pradesh cannot eliminate PPR and then remain PPR-free without the rest of India following suit, and it will be important to have a national common programme aiming for countrywide eradication. To face the challenge, we will need to strengthen and increase vaccine production, improve vaccine delivery, and strengthen diagnostic capacity. To achieve these goals, it may be necessary to adapt the National Programme for Rinderpest Eradication into a National Programme for Peste des Petits Ruminants Eradication. Whatever we do, we must not let the new ideas learned from rinderpest eradication die before they are applied to other diseases such as PPR.

Reference

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AFTER RINDERPEST – WHAT NEXT?

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Historically, the term "disease eradication" has often been loosely applied to describe the absence, over a prolonged period, of clinical disease in a given territory. "Partial elimination" or "progressive control" would appear to be more appropriate terminology, and these scenarios lend themselves to obtaining better insight into the success of area-wide disease control. Taking the historical efforts in Europe against OIE former List A diseases as a guide, we note that rinderpest was always the first disease to disappear from a country. Sweden has remained free from rinderpest since 1700, Denmark since 1782 and Norway since 1789. An increasingly large number of countries in Europe became free from rinderpest, then CBPP, then sheep and goat pox, glanders, FMD, brucellosis, Newcastle disease, classical swine fever, anthrax and rabies, mostly in that order.

Technical feasibility arguably played a major role in explaining the pace of progress and the disease sequence, as did the magnitude of the problem and its negative impacts on agriculture and public health. Geographic isolation also played a major role, as evidenced by lower occurrences of List A diseases reported for the United Kingdom, Malta, Cyprus, Iceland and Scandinavia. These countries or territories rank first in terms of number of List A diseases eliminated, followed by the Baltic countries, central Europe, and then countries in western Europe. The European Mediterranean and southeastern Europe have always been less successful in area-wide disease control efforts. Countries in central Europe were particularly successful during the Soviet era, when public veterinary services were strongly commited and line management was in place. Certain List A diseases were eliminated, even in situations where animal productivity levels hardly sufficed to justify the expenditure. Hence, technical feasibility, geographic isolation, socio-economic justification and political commitment all played roles in explaining Europe's progress in obtaining freedom from List A diseases.

If we assume that the economic incentive for progressive disease control is highest in places where there is a relatively high demand for animal-source food, the benefits from area-wide disease control might be expected to be highest in eastern and southern Asia. However, these countries lag behind in that little has been done against prevailing high-impact animal diseases, despite the important animal production levels. India, with the largest ruminant population in the world and ranking first in dairy production, is plagued by FMD, PPR and brucellosis. China, ranking first in pig and domestic waterfowl production and with a very significant broiler industry, reports multiple epidemic avian and swine diseases, which also pose a threat to neighbouring countries. For much of the remainder of the Old – and the New – World, the projected benefits from progressive disease control carried out in an area-wide fashion and at an ecoregional level would be less consistent. Spatial heterogeneity in profits would complicate the coordination of efforts among countries. The close mix of traditional livestock systems and commercial animal production plants complicates technical and operational feasibility. Europe, in contrast – building on its historical disease-freedom platform – has become a main exporter of animal protein commodities. The New World has always been free from a number of epidemic livestock diseases that are ubiquitous in the Old World. Nevertheless, with Brazil and the United States of America as major exporters of livestock products, numerous classical and new emerging transboundary and/or zoonotic disease challenges need to be addressed.

Livelihood considerations, particularly those related to protein food security and income generation, are a main argument for justifying disease control in poverty-stricken rural areas where ruminants or other livestock constitute the main source of sustenance. In pastoral communities that move across wide areas, disease control would also benefit adjacent more economically productive livestock areas, taking the justification beyond humanitarian considerations.

Accordingly, the identification of single-target disease programmes for progressive control by ecoregion, as was carried out under GREP in Africa and Asia, requires a cautious balancing of international public good arguments, local socio-economic justification and technical feasibility. For example, PPR may be proposed as a single focus requiring urgent attention for countries in southeastern Africa because the disease is invading new areas there, where large numbers of susceptible small ruminants have never been exposed to the disease. However, the progressive control of PPR would appear more practical in North Africa and the Near East. In the Horn of Africa, another area rich in sheep and goats, progressive control of PPR is technically less feasible, and the necessary sustained funding support could pose a problem. In remote harsh environments of central Asia, PPR control poses practical problems, despite being highly desirable for socio-economic and livelihood reasons.

Looking at high-impact TADs other than PPR, the progressive control of FMD in south Asia presents a relatively low apple on the tree, and it would bring relatively major socio-economic rewards. However, the requirement for sustained funding over an extended period may pose challenges. Brucellosis control in the Near East appears to be another attractive target, given the relevance of smallholder dairy production, but again donor funding and practical implementation constraints would have to be overcome. A different target would be the progressive elimination of sheep and goat pox, which is likely to be successful, but would be more difficult to justify. Where single-target disease programmes are unviable, there may be the option of containing several diseases at once, exploiting economies of scope. For example, combined PPR, FMD and brucellosis control could be a viable target to boost ruminant livestock productivity in south Asia, the Near East and north Africa. Technically however, these multiple disease programmes are more cumbersome. An additional option would be to tackle PPR, brucellosis and RVF jointly in the Greater Horn of Africa, but practical issues would complicate such an approach.

Finally, there is the option of broadening the scope further and considering ecoregional animal production categories in their entirety, taking disease constraints as only one of many obstacles constraining sustainable development. Examples are the small ruminant dairy production sector in the Near East and small ruminant meat production in central Asia, which require an interdisciplinary and cross-sectoral scope. Building on the momentum created by GREP, future prospects for the progressive control of livestock diseases exist and are viable, provided that we overcome the greater complexity presented, which demands skilful juggling of developmental, livelihood, economic, technical and other factors.

Discussion

Dr Masiga emphasized that the lessons learned from rinderpest would be very important in any efforts to move forward on a programme for controlling and possibly eradicating PPR. During rinderpest eradication conventional veterinary services often did not work well in some pastoral areas. In these areas, besides training and utilizing CAHWs, it was also necessary to talk to community leaders and convince them of what the programme was trying to achieve. The leaders would then help carry the message to everyone in the community. It was also important to apply the ecosystem approach to final control in some livestock-owning communities; if this was to be done again with PPR, it would be necessary to identify who would coordinate such activities.

Dr Saley Mahamadou reported that dealing with PPR had become a priority in the Niger, where a PPR-like syndrome had been seen in camels. However, he and his colleagues did not have the resources to combat PPR fully – the sheep and goat population exceeds 20 million. He could see that better regional coordination among the countries in the region would be needed if any form of realistic control was envisaged. What was the EU's view of this in the light of the Niger's need to do something about poverty alleviation?

For *Dr Raja Rafaqat,* the meeting and his own experience in Pakistan made it clear that PPR is a serious emerging problem. The meeting presentations had brought out the point that PPR is a good candidate for eradication, therefore, he strongly suggested that FAO selected PPR for global eradication.

Dr Manzoor Hussain added that much of the current work in Pakistan was not directed towards national goals. A regional approach was essential, within which there should be clear national goals. All international organizations, especially FAO and OIE, were required to take on the role of international coordination. Regional meetings on PPR were required, as well as a pathway such as that used for rinderpest.

The Chair, Dr Taylor asked Dr Rweyemamu to explain how GREP had developed.

Dr Rweyemamu replied that it was largely the result of what regional organizations needed at the time. Regional organizations, including the East African Community and the Southern African Development Community had already requested a coordinated PPR programme to prevent further southerly spread of the virus in Africa. At this stage the urgent issue was to prevent PPR from becoming endemic in the region. A programme to combat PPR could spearhead a much bigger drive to improve small ruminant health in the region.

Dr Chibeu noted that ongoing regional actions against PPR, such as Vaccines for the Control of Neglected Animal Diseases in Africa (VACNADA), should be taken into account. AU-IBAR has a strategy for PPR and it was definitely necessary to embark on progressive control of the disease and to prevent further southerly spread.

Dr Razzig reported that PPR was a big problem in the Sudan, where he and his colleagues were using a recombinant vaccine to immunize animals. They recognized that regional cooperation was needed and sought to be part of VACNADA.

Dr Aidaros congratulated FAO on its achievement in the field and hoped that this may be the start of PPR eradication. There was need to see what could be done to help some countries understand their PPR status, and assistance in surveillance would be a good start in this.

Remembering that Dr Libeau had shown the meeting a map of the current global distribution of PPR, *Dr Taylor* noted that this disease is far less widespread than RP once was. Were there firm geographic barriers to help an ecosystem-based approach to the control and possible eradication of PPR? *Dr Unger* added that trade as well as geographic barriers affected disease spread. He noted that as Myanmar and Zimbabwe were currently predominantly exporters of stock they were less likely to import disease than countries that import large numbers of animals. Veterinary services would have difficulty keeping up with the vaccinations required in small ruminants for PPR control. Could the delivery of vaccines be transferred to local veterinarians or even down to the households themselves? Were there different formulations that might make this easier, such as vaccine in eye drops, or multivalent vaccines, which are cheaper and would reduce the costs of delivery?

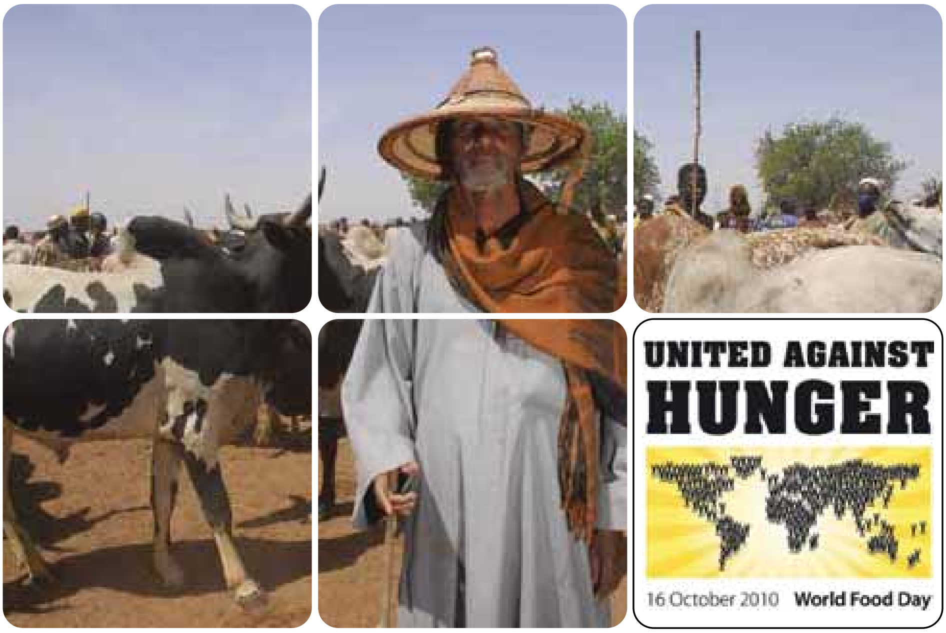
Dr Mariner reported that his group was already exploring the development of heat-stable PPR vaccines and improved models for vaccine delivery. However, they had to be realistic about the size of the job. Small ruminants have a much higher reproductive rate or natural herd recruitment rate than cattle, perhaps 2. 5 times as much. This means that at least 2. 5 times as much immunization may be required as was needed for rinderpest – and probably even more given that there are about 2. 3 times as many sheep and goats as cattle. At present the reproductive rate, R_0, for PPR was unknown, but it could be as high as four. If this was so then all modelling suggested that very high rates of immunity would be needed to break transmission. He also wondered if it was clear whether efforts were designed to control PPR itself or the impact of the disease. If PPR control were to be integrated into a broader animal health programme, the other diseases addressed should be dictated by local priorities.

Dr Ozawa recommended starting with studies such as into the role of wildlife, the possible resistance of some breeds of sheep and goats, and an appraisal of all types of vaccine delivery systems.

Dr Jeggo suggested that the Global FMD Research Alliance would be a good working model for the necessary coordinated research.

Dr Rweyemamu agreed and added that the research should be through partnerships between, where possible, scientists and institutions in the countries where PPR is a problem, as well as with the more established reference laboratories.

Annexes



WORLD FOOD DAY 2010 and
THE GLOBAL RINDERPEST ERADICATION
PROGRAMME (GREP)

GREP SYMPOSIUM and HIGH LEVEL MEETING

Agenda

AUSTRIA ROOM (C237)

GREEN ROOM (A122)

13 October 2010

The Global Rinderpest Eradication **Symposium**

Objectives:

1. Draw lessons learned from the GREP
2. Assess the economic impact of rinderpest eradication on food security
3. Review / adopt the PPR control strategy for small ruminant health

09:00–9:15	**Opening** Welcome by FAO	*M. Traoré (Assistant Director-General, Agriculture and Consumer Protection Department)* *J. Lubroth (Chief Veterinary Officer)*
	Session 1: Rinderpest *(Chair: J. Lubroth)*	
9:15–9:35	ITEM 1: FAO/GREP achievements	*F. Njeumi (GREP Secretariat)*
9:35–10:10	ITEM 2: Regional experiences *(Chair: P. Roeder)*	
	• African Union/Interafrican Bureau for Animal Resources (AU/IBAR): Joint Programme 15, Pan-African Rinderpest Campaign (PARC), Pan African-Programme for the Control of Epizootics (PACE), Somali Ecosystem Rinderpest Eradication Coordinating Unit (SERECU)	*D. Chibeu/H. Wamwayi*
	• Middle-East	*H. Aidaros*
	• Russian Federation	*S. Starov/S. Rybakov*
10:10–10:40	**Coffee break**	
10:40–11:25	ITEM 2: Regional experiences continues	
	• Central Asian neighboring countries	*H. Manzoor/H. Raja*
	• China and South-East Asia	
	• Indian sub-continent and South Asia	*R. Gangadharan/M.Rajasekhar*
11:25–11:45	Discussion Items 1 and 2	
11:45–12:30	ITEM 3: Lessons learnt by International Organizations on rinderpest eradication	
	• The OIE pathway and guidelines	*K. Miyagishima*
	• Laboratory support in countries	*H. Unger/M. Jeggo*
	• Sero-monitoring and vaccine quality control	*K. Tounkara*
	• World Reference Laboratory support	*M. Baron/J. Anderson*
	• Economic impact of rinderpest eradication	*M. Rich*
12:30–14:00	**Lunch**	
14:00–15:45	ITEM 4: Key individual lessons learnt *(Chair: H. Ozawa)*	
	• Surveillance, participatory disease search and modeling	*J. Mariner/P. Roeder*
	• Role of Community Based Animal Health Workers	*T. Leyland*
	• Networks (laboratory and epidemiology)	*B. Diop/K. Kiani*
	• Partnerships and donors support	*B. Rey*
	• Programme management (regional and national)	*R. Bessin*
	• Vaccines and vaccination	*M. Rweyemamu/W. Taylor/J. Mariner*
	• Performance Indicators and guidelines in disease elimination and eradication	*M. Jeggo/A. Wilsmore/A. James*
15:45–16:15	**Coffee break**	
16:15–16:45	Discussion Items 3 and 4	
16:45–17:15	ITEM 5: Post eradication roadmap *(Chair: K. Miyagishima)*	
	• Post eradication strategies	*W. Taylor/J. Pearson*
	• Role of the FAO/OIE Joint Committee	*A. Shimshony*
	• Draft Declaration (resolution and guidelines for June 2011) documents for Director-General	*Y. Ozawa/S. Edwards*
17:15–17:30	Discussion Item 5	
18:00–20:00	**Welcome reception**	

14 October 2010

GREEN ROOM (A122)

9:00–10:30	**Session 2: *Peste des Petits Ruminants*** *(Chair: W. Taylor)*	
	ITEM 1: Lessons learnt from GREP for PPR and tools for PPR eradication	*P. Roeder/F. Njeumi/P. Rossiter*
	ITEM 2: Potential implications of rinderpest eradication for PPR (virological aspect)	*G. Libeau*
	ITEM 3: PPR in small ruminant health	*J. Slingenbergh/A. El Idrissi*
10:30–11:00	**Coffee break**	
11:00–12:00	Discussion Session 2	
12:00–13:00	**Recommendations and closure**	

The High Level Meeting • Rinderpest and Beyond

Objectives

1. Celebrate and share the success of rinderpest eradication
2. Share the outcomes of the GREP Symposium with Ministers highlighting GREP success stories
3. Communicate FAO's animal health strategy and post rinderpest eradication

KING FAISAL ROOM (D263)

14:00–14:30	**Opening** Welcome by the Director-General FAO	
14:30–15:00	ITEM 1: GREP Symposium report	*J. Lubroth*
15:00–15:30	**Coffee break**	
15:30–16:00	ITEM 2: Socio-economic impacts of rinderpest eradication	*J. Otte*
16:00-16:40	ITEM 3: FAO's animal health post-eradication plan and future vision	*J. Lubroth*
16:40-17:30	ITEM 4: Discussion	

15 October 2010

Morning	**World Food Day: Statement of the FAO Director-General** (Plenary Hall)

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A world without rinderpest has been a long-awaited goal since the seminal work by G. Lancisi in early XVIII century. Early reports of simple hygienic measures, such as quarantine and slaughter, stopping the transmission of infection and eradicating the disease at the local level showed that global eradication should be possible. More difficult to achieve, however, were control and eradication where cattle populations were large and mobile and their owners averse to quarantine and slaughter. To combat rinderpest in these populations, vaccines were developed and immediately seen to offer another weapon in the drive towards eradication. For global eradication, this meant coordination across those regions of the world where the virus was endemic: Eurasia and Africa. The year targeted for achieving eradication was 2010. The global coordination provided by the FAO Global Rinderpest Eradication Programme (GREP) orchestrated the efforts and ideas of regional organizations, national veterinary services and individuals alike, assisting them in identifying areas of high disease risk or uncertainty, and focusing improved vaccine delivery and disease surveillance efforts on these often inaccessible areas.

Considering the impact of rinderpest eradication on food security in many countries, and the current rinderpest epidemiological situation, in line with the GREP deadline of 2010, the Director-General of FAO reviewed the situation on the occasion of World Food Day on 15 October 2010. His statement announced the "end of FAO's rinderpest field operations", thereby declaring that FAO considered rinderpest to be eradicated from livestock and wildlife (while recognizing the ongoing formal process of evidence-based review by a Joint FAO/OIE Committee, leading to simultaneous declarations of global freedom from rinderpest by both organizations in mid-2011).

As one of the final acts of coordination against rinderpest, the GREP Secretariat organized the GREP Symposium (13 to 14 October 2010). The following proceedings bring together papers and discussions from the organizations and people who brought about this "*greatest achievement ever*", their reviews of what went well and of what did not, and their views on the way forward.