

Conquering the Cattle Plague The global effort to eradicate rinderpest

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armers have confronted the scourge of rinderpest, or cattle plague, ever since cattle were domesticated some 10,000 years ago. For centuries, humankind has depended on livestock for draft power, milk, meat, skins, and manure. Rinderpest—which in its severest form can kill 95 percent or more of the animals it infects—has had devastating effects, blighting the lives of farmers throughout Africa, Asia, and Europe. It has been described as "the most dreaded bovine plague known, belonging to a select group of notorious infectious diseases that have changed the course of history."¹

Rinderpest was detected and confirmed for the last time in 2001 in Kenva. Few veterinarians and even farmers alive today have seen the disease, and its existence is fading from memory. The eradication of rinderpest can be viewed as an achievement on par with the eradication of smallpox from the human population, the only other time an infectious disease has been eradicated. This remarkable feat was accomplished thanks to the efforts of scientists around the world to develop and perfect vaccines and-just as important-to international collaboration and coordination aimed at monitoring the disease and eliminating it wherever it lingered. Rinderpest eradication was the outcome neither of a single project nor the efforts of a single agency; rather, it was the result of a series of periodic, internationally coordinated efforts built on the ongoing national programs of many affected countries during the course of many decades.

History of the Disease

Rinderpest is thought to have had its origins as far back as the domestication of cattle in Asia. possibly in the region of the Indus River in modern-day Pakistan. It has had a severe impact not only on domesticated ruminants and swine, but also on many wild animals such as African buffaloes, giraffes, and warthogs. Related to the human measles virus, rinderpest is a contagious disease characterized by necrosis (cell death) and erosions throughout the digestive tract. Affected animals develop fever, discharges from the eyes and nose, erosions of the mucosa or soft lining in the mouth, diarrhea, dysentery, and death. Animals that recover are debilitated and suffer a long convalescence—although they are thereafter immune to the virus. When the virus is introduced to a formerly unaffected area, it results in high mortality, but in areas where rinderpest is endemic, the morbidity and mortality rates can be low because many animals that survive an earlier exposure (and perhaps received vaccination) are protected.

Warfare was a potent vehicle for spreading rinderpest throughout Europe, Asia, and the Middle East, because of the large cattle herds traveling with marauding armies. The Huns and Mongol invaders brought the disease from Asia into Europe, where it was spread by the movement of livestock meant to feed the populations of the burgeoning cities. For many centuries, no European countries were consistently free from

This chapter is based on Roeder, P. and K. Rich. 2009. *The global effort to eradicate rinderpest*. IFPRI Discussion Paper. Washington, D.C.: International Food Policy Research Institute.

rinderpest. World War II led to a major resurgence of the disease throughout East and Southeast Asia. As late as the early-1990s, the civil disturbance caused by the Gulf War resulted in a major upsurge of infection in Iran, Iraq, and Turkey.

The looting and social disruption of warfare was not alone in spreading rinderpest. Organized trade in cattle, largely from Russia, repeatedly introduced rinderpest into recipient countries in Europe and elsewhere in the 17th, 18th, and 19th centuries. As a result, from 1857 to 1866, Europe was stripped of cattle.

Introduced into eastern Africa in the late 19th century, rinderpest set off what came to be known as the Great African Pandemic. It spread from the Indian to the Atlantic Ocean and moved rapidly down the eastern seaboard of Africa in grazing animals both domestic and wild, reaching Southern Africa in 1896. When the first major African pandemic died down, it left behind pockets of infection from which arose periodic epidemics and pandemics.

An array of sanitary measures—such as the culling of infected animals combined with government compensation for farmers, the safe disposal of carcasses, sanitary cordons around infected farms, and strong legal enforcement—was gradually adopted across Europe in the 18th and 19th centuries, setting the stage for the control and eventual eradication of rinderpest there in 1908. But in much of Africa and Asia, rinderpest remained a persistent scourge throughout the 20th century.²

Developing a Vaccine

The eradication of rinderpest in the developing world during the 20th century depended on two factors: first, the discovery of an effective vaccine that worked well in tropical countries, and second, the adoption of a system of mass vaccinations followed by surveillance, and focused vaccinations in case of outbreaks.

In the late-1890s, South African scientists showed that immune serum (serum taken from a recovered animal) and virulent blood (blood taken from an infected animal), when given simultaneously, produced long-term immunity to rinderpest, despite the risk of disease inherent in its use. By 1928, this "serum-simultaneous" method developed independently had eliminated rinderpest from European Russia.



Rinderpest takes its toll on the livestock population in the 1890s, South Africa

Throughout the 20th century, the effort to develop a more effective vaccine continued, with important breakthroughs along the way. Scientists across the globe developed and improved upon attenuated vaccines—that is, vaccines using live but less virulent viruses—in the mid-20th century. Yet the search continued for a vaccine that would provide long-term protection to all types of cattle, would not require the accompaniment of an immune serum, and would not sicken the animals being immunized.

In the late-1950s, Walter Plowright, working at the East African Veterinary Research Organization in Kenya, achieved a breakthrough using tissue culture-in other words, he grew a virus in cells in a lab instead of in animal hosts. His tissue-culture rinderpest vaccine produced neither lesions nor fever and was safe and effective for cattle of all breeds and ages and both sexes. Its only drawback was that it had to be kept at a low temperaturea distinct disadvantage in African climates. However, in the late-1980s, scientists developed a variant of tissue-culture rinderpest vaccine, called Thermovax, that could be kept at ambient temperatures in the tropics for up to four weeks. This vaccine was widely used to great effect in community-based vaccination programs in Africa, particularly in remote areas of Sudan, Somalia, Kenya, Ethiopia, Tanzania, and Uganda, as well as in Afghanistan.

Eliminating Rinderpest

With rinderpest vaccines becoming available, countries and regions began adopting major campaigns aimed at eliminating the disease. In 1948 in western China, for example, rinderpest was killing millions of cattle, buffaloes, and yaks. Recognizing that feeding its millions of citizens required eliminating the disease, the new government made eradicating rinderpest a high priority. The Chinese also undertook heroic measures in this battle. For example, to combat pockets of infection in the Himalayas at a time when there was little or no motorized transport and no refrigeration, the vaccine virus was transported in live, infected sheep on the backs of yaks and horses to sites where the vaccine was produced for immediate use. Success in China came rapidly. No outbreak has occurred there since 1955 and the vaccination process ceased in 1956.

Success in India was slower. In 1954, India initiated its National Rinderpest Eradication Programme. The program aimed to systematically vaccinate 80 percent of cattle and buffaloes in five years, to be succeeded by a follow-up period during which the remaining 20 percent plus the annual calf crop would be vaccinated.3 Overall, mass vaccinations succeeded in eliminating endemic rinderpest in some states but did not prevent it from being reintroduced. By the mid-1980s, it was clear that the program was failing, and the country shifted course. In the endemic states, mass vaccinations were re-launched with the goal of covering 90 percent of the cattle population within three years. In non-endemic areas, authorities administered focused vaccinations only in the event of an outbreak. Strict controls on the movement of cattle helped reduce the transmission of the disease within India, and rinderpest was eliminated from the country in 1995.

Although China and India managed to eradicate rinderpest within their borders through their own national programs, it took global coordination to wipe out the disease in other parts of the developing world. In the 1960s and 1970s, a number of African countries, coordinated by the Organization of African Unity, joined forces in an effort called Joint Project 15. This project aimed to eliminate rinderpest using intensive, internationally coordinated vaccination campaigns. Although Joint Project 15 was highly successful at first, it failed to eliminate three or four persistent reservoirs of rinderpest, and new pandemics eventually emerged. By the early-1980s, rinderpest pandemics in East and West Africa were converging in Nigeria, in what became known

as the second Great African Pandemic. National emergency control programs, many mounted by the Food and Agriculture Organization of the United Nations (FAO), brought the resurgence under control by 1986. Though devastating, these events did have the beneficial effect of stimulating a continentwide Pan-African Rinderpest Campaign (PARC)—and ultimately the Global Rinderpest Eradication Programme (GREP).

Conceived in 1992 and launched in 1993, GREP operated under the auspices of the FAO, which provided coordination assistance and offered technical guidance. When GREP began, authorities had no clear picture of where rinderpest was occurring or how the virus survived and spread. Once scientists established the geographic extent of rinderpest infection and recognized that hidden reservoirs of infection were giving rise to visible epidemics in normally unaffected populations, it became possible to develop a strategy for its progressive elimination.

GREP set a deadline of 2010 for global freedom from rinderpest, based on internationally coordinated rinderpest-control activities on three fronts: Africa, West Asia, and South Asia. The international



Vaccine preparation in the Pan-African Rinderpest Campaign, Sudan



Rinderpest-free cattle in Omdurman market, Sudan

community would fund these campaigns—often with nominal national contributions—and the regional organizations would implement them. After successfully carrying out rinderpest-control activities, individual countries would undergo an accreditation process to be declared free from rinderpest. The World Organization for Animal Health defined a pathway to accreditation that incorporated a series of verifiable epidemiological objectives, including a requirement that countries cease all vaccinations. Completion of all steps on the pathway to eradication was expected to be far less costly than continuing with endless rounds of mass vaccinations.

As GREP helped spread information on the prevalence and risk of rinderpest, the focus of rinderpest control thus shifted from vaccination to surveillance—but this shift did not always occur quickly or easily. A number of countries in Africa and Asia sought security by continuing to implement annual vaccination campaigns for many years after rinderpest had been eradicated from their territory and the risk of reinvasion had become minimal.

Nonetheless, the shift away from mass vaccinations to surveillance and accreditation did occur over time. The Pan-African Rinderpest Campaign, which was implemented in 20 countries in West Africa and 7 countries in East Africa, combined emergency action to control existing outbreaks with efforts to strengthen veterinary services, for example. It also included a phased vaccination and surveillance program aimed at eradicating remaining pockets of the disease. As noted previously, the last known case of the disease worldwide occurred in Kenya in 2001.

Impact of Rinderpest Eradication

By preventing the illness and death of millions of livestock, rinderpest eradication has generated enormous benefits for people's livelihoods and food security. Eradication has prevented the devastating effects of rinderpest on poor rural households with limited assets or few alternatives to livestock production. Given the many links in the livestock marketing chain, the cessation of rinderpest means increased economic activity among traders, slaughterhouses, brokers, retailers, and other stakeholders. In Pakistan, for instance, rinderpest impeded international trade with the Gulf countries, which sought to keep the disease away from their borders. Cattle exports from Pakistan to the Middle East increased dramatically after those states lifted a ban, imposed because of rinderpest, when Pakistan declared provisional freedom from the disease in 2003 (see Figure 16.1).

Lessons from the Rinderpest Eradication Experience

Obviously, the biology of different diseases and hosts must inform the methods to control and eradicate diseases, but the experiences with rinderpest offer some lessons. The rinderpest-eradication strategy evolved from annual, institutionalized vaccination campaigns to a process of seeking active infection, containing and eliminating it based on a sound understanding of the disease, and then confirming the absence of the rinderpest virus. These lessons learned could act as a model for other endeavors in animal disease control.

A campaign of global eradication requires an international coordinating body. For rinderpest, the FAO was mandated by the ministers of agriculture of its member countries to assume this role in 1993, and it provided the basic funding for the GREP. FAO proposed and guided the strategy, monitored progress, and hosted an international forum for exchanging technical information.

At the same time, however, global campaigns are too large to be operated by a central unit only. Regional organizations committed to working closely with the global coordinating body are needed to coordinate regionalized control campaigns and to certify disease freedom. Regional ownership of the accreditation process can help put pressure on intractable countries to undergo the process. Although a number of regional programs were envisioned, in reality only the African regions assumed responsibility for rinderpest eradication through PARC. To safeguard the program, the GREP secretariat ended up promoting rinderpest eradication in parts of the world not covered by regional campaigns.

A global disease eradication program needs a clear and realistic aim supported by a timetable and a step-by-step approach. Before the program starts, planners need to consider such issues as



Source: FAO (Food and Agriculture Organization of the United Nations). 2009. FAOSTAT statistical database. Rome.

vaccine delivery systems, the capacity of targeted countries' veterinary services, legal provisions, and policy issues such as cost recovery.

It is also important to take into account the attitudes of livestock owners by consulting with them beforehand. In Ethiopia, for example, the central planning of vaccination campaigns failed to place vaccination teams at sites amenable to pastoralists and antagonized them by insisting on vaccinating all ages of cattle, which the pastoralists knew to be unnecessary. Rinderpest was quickly eliminated once the program began basing its vaccinations on the preferences of livestock owners, and combining this effort with community-based animal health worker programs in remote areas and the use of a thermostable vaccine.

A disease-eradication campaign also needs appropriate technical tools, such as a clear and evolving understanding of the epidemiology of the targeted disease and safe, effective, affordable, and quality-assured vaccines. The setting of qualityassurance procedures for rinderpest vaccines and the establishment of a facility in Africa where vaccine assessment and certification could be performed made an invaluable contribution, not only to PARC, but also to GREP outside Africa, by offering services to campaigns in other countries.

Furthermore, for vaccines that are to be used in developing countries, it is important that they retain their potency in the warm temperatures of the tropics—in other words, they should be thermostable. Vaccines that might be fit for use in temperate or developed-country environments are not necessarily useful in tropical or developing environments and remote locations. The seminal research that led to the provision of a thermostable rinderpest vaccine made a significant contribution to eradicating rinderpest from remote areas in Africa and Asia.

A set of diagnostic tools for detecting the disease is also needed to support rapid diagnosis and surveillance. In the case of rinderpest, one issue that has caused serious problems in monitoring and accreditation is the inability to discriminate between antibodies induced by vaccination and wild virus infection. A test to distinguish between infected and vaccinated animals would have sped up the accreditation process. Instead, scientists had to wait until a sufficient number of animals had been born after the vaccinations ceased before they could test a suitable cohort to see if the rinderpest virus was still circulating.

Finally, a clearly defined accreditation process for disease freedom is needed. From the start of GREP, it was envisaged that the World Organization for Animal Health would assume responsibility for operating the rinderpest freedom accreditation process. Stringent conditions for accreditation were set, and slow but steady progress was made in accrediting countries as free from the rinderpest disease or infection. Setting a deadline of 2010 for global rinderpest eradication was helpful in guiding countries along the pathway to accreditation. In fact, it is likely that rinderpest stopped circulating in both domesticated and wild animals in 2001-nine years before the deadline-vet no declaration of global freedom has been made because the remaining unaccredited countries are increasingly reluctant to devote any resources to the accreditation process—even though they have eradicated rinderpest. As a result, although no known cases of rinderpest have emerged since 2001, accreditation of all countries individually may not be possible by 2010 (see Figure 16.2). How this will be resolved is unclear. It may be that not every single country needs to be formally accredited as free from rinderpest and intransigent countries do not need to be coerced into undertaking the accreditation process. In any future eradication program, the final accreditation process, and the manner in which an announcement of global eradication is to be made, needs to be clearly defined in advance.

Conclusion

After plaguing farmers in Africa, Asia, and Europe for thousands of years, rinderpest has finally been eliminated. Although global accreditation of freedom from rinderpest has not vet been completed, some 127 countries around the world have been declared free of the disease, and another 11 are in the accreditation pipeline. Besides increasing confidence in food production through cattle and buffaloes, growing confidence in rinderpest freedom is leading to an increase in trade in livestock and their products from previously infected countries, with enormous benefits for producers and consumers. By saving millions of livestock and contributing to the increasing production of animal products, rinderpest eradication has improved food security and the livelihoods of millions of people worldwide.

Figure 16.2— Status of accreditation of rinderpest freedom, 2009



Source: World Organization for Animal Health. 2009. www.oie.int/eng/status/Rinderpest/en_RP_free.htm.

Global eradication of an infectious disease has occurred only twice, with smallpox and rinderpest. The experience of rinderpest eradication shows how much a careful combination of scientific expertise and close international cooperation can accomplish.

Removing Rinderpest from Remote Areas: The Role of Community-Based Animal Health Workers

Reaching livestock keepers with veterinary services is a perennial challenge, especially where farmers and pastoralists live in remote areas beyond the reach of government service delivery systems. As late as the 1990s, this challenge was seriously hindering efforts to eradicate rinderpest. Outbreaks were still to be found in parts of South Sudan, East Africa, and the Horn of Africa, areas where armed conflict or the remoteness of pastoral communities were hampering eradication efforts.

Two breakthroughs helped wipe out these last pockets of rinderpest. First was the development in the late-1980s of Thermovax, a heat-stable formulation for the rinderpest vaccine that was far less dependent on coldchain facilities. Second was the realization by international agencies, national governments, and nongovernmental organizations that community-based animal health workers (CAHWs) could be effective in vaccinating cattle in far-flung pastoralist communities.

While the development of the improved vaccine is well documented, less recognized is the role that CAHWs played in combating rinderpest. This novel approach was developed by nongovernmental organizations working with livestock keepers in East Africa and India during the 1980s. It uses community participation to select people from within a rural community to be trained as animal health workers, identify livestock diseases and report outbreaks, and develop locally-acceptable incentives to keep these services running.^a

Community-based animal health workers were specifically used to combat rinderpest in South Sudan, the Afar region of Ethiopia, Karamoja in Uganda, and Turkana in Kenya, as part of the Pan African Rinderpest Campaign. The effort, directed by the Organization of African Unity/Interafrican Bureau for Animal Resources and implemented in partnership with various nongovernmental organizations working on the ground, quickly achieved dramatic results.

In South Sudan, where armed conflict had disrupted cold chains and brought vaccination efforts to a standstill by 1992, a community animal health worker program using the new vaccine succeeded in vaccinating over 4.3 million cattle between 1993 and 1995; as a result confirmed outbreaks of rinderpest decreased from 11 in 1993 to only one in 1998.^b In Ethiopia's Afar region, where government teams had been unable to contain the disease through a 15-year campaign dating back to the late-1970s, community animal health workers succeeded in vaccinating 73,000 cattle in just one season in 1994. Because of this success there were no further cases of rinderpest after 1995; the reservoir of infection had been effectively removed.

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NOTES

- 1. Scott, G. R., and A. Provost. 1992. *Global eradication of rinderpest.* Background paper prepared for the Food and Agriculture Organization of the United Nations expert consultation on the strategy for global rinderpest eradication. Rome: FAO.
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- 3. Taylor, W. P., P. L. Roeder, and M. M. Rweyemamu. 2006. Use of rinderpest vaccine in international programmes for the control and eradication of rinderpest. In *Rinderpest and peste des petits ruminants: Virus plagues of large and small ruminants*, ed. T. Barrett, P. P. Pastoret, and W. Taylor. Amsterdam, The Netherlands: Elsevier.