Alumnus plays a pivotal role in eradicating rinderpest disease

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A Maasai livestock owner whose cattle had suffered from rinderpest grazes his now-vaccinated cattle in a village southwest of Nairobi, Kenya. Credit: Tony Karumba/FAO

Eliminating disease is a lofty goal, though one rarely attained by humankind. In fact, modern science has achieved it only twice: first with smallpox in humans several decades ago and then again last year with a disease known as rinderpest or "cattle plague."

Last June, the U.N. Food and Agriculture Organization (FAO) declared that rinderpest was officially eradicated following decades of work in numerous countries. Rinderpest, once a major scourge of cattle and similar wild and domesticated species, such as yaks and buffalo, cut a wide swath across Asia, Europe, the Middle East and Africa. Over the millennia, famine and economic devastation were left in its wake.

Dr. Juan Lubroth, Ph.D. '95, the FAO's chief veterinary officer based in Rome, worked for years to defeat the disease. Yet he recognizes that this tremendous accomplishment was possible only through the combined efforts of generations of veterinarians and scientists, governments, nongovernmental organizations and farmers across the globe. The eradication of the first animal disease is a feat that will save millions of cattle and, in turn, will improve the lives and livelihoods of the millions of people who depend on livestock as a food source and for income.

"When herds die, people die," explains Lubroth. "For humans, the effects on nutrition, whether through availability of milk, meat or blood, are enormous."

A passion for animals and science

A native of Spain, Lubroth dreamt of being a veterinarian as a boy. By the age of 11, he began working in an animal clinic near his home in Madrid. His vision has always been to improve the lives of both animals and people. "We share environments, we share pathogens," he says.

After working as a wildlife veterinarian in the Caribbean for the University of Georgia, Lubroth worked for the U.S. Department of Agriculture at Plum Island Animal Disease Center in Long Island Sound off the Connecticut coast, and then in Mexico as part of a bilateral commission for the prevention of exotic diseases, before coming to Yale in 1990 to initiate his doctoral studies. Once here, he trained with Robert E. Shope and Robert B. Tesh at the Yale Arbovirus Research Unit. "I couldn't have asked for a better advanced education," he says. "Yale provided a lot of flexibility and opportunity to hone my scientific skills."

Upon leaving Yale, Lubroth continued his service with the Department of Agriculture as an epidemiologist in Brazil in South America's efforts to eliminate foot-and-mouth disease and to ensure capabilities in emergency preparedness and rapid response. Before joining the United Nations' Rome office in 2002, he headed the Diagnostic Services Section and the Reagents and Vaccine Section at Plum Island.

Origins of a scourge

Rinderpest's origins can be traced to domesticated cattle in the steppes of Central Asia thousands of years ago. It spread to Europe and Asia through military campaigns and livestock imports, and in the 19th century it was introduced into Africa by the Italian incursion into what is now Eritrea. It reached all the way to Brazil and Australia in the 1920s but was quickly eradicated through the mass elimination of infected animals and, indeed, of any animals remotely suspected of having contact with sick animals.

The disease has played a role, though often unacknowledged, in seminal events throughout world history. Outbreaks preceded the collapse of the Roman Empire, Charlemagne's conquest of Europe, the French Revolution and the impoverishment of Russia. Upon reaching sub-Saharan Africa at the end of the 19th century, rinderpest triggered a famine that was followed by colonization.

It was only in the mid-1950s that a less-virulent rinderpest virus was cultured in bovine tissues–essentially a vaccine that was safer and inexpensive to produce and that could be standardized for quality and efficacy. This tool alone turned the tide, since the vaccine granted lifelong immunity. However, the vaccine had to be kept cool, and in Africa, the Middle East and parts of Asia, high temperatures usually resulted in failed vaccination campaigns.

A highly contagious disease caused by a morbillivirus, rinderpest is closely related to human measles and canine distemper. Afflicted animals suffer a horrific death: cattle and buffalo usually experience high fever, discharges, lesions in the mouth, internal hemorrhaging and diarrhea. Within days, they die dehydrated and emaciated.

In the late 20th century, targeted vaccination accompanied by advances in vaccine development began to tip the odds in favor of winning the battle. But it was the purely human element of old-school teamwork that, in the end, provided science with a decisive victory.

“It was tackled by countries working together, building trust and friendships regardless of nationality, religion or color,” says Lubroth.

Enter the FAO

Though the United Nations’ efforts to control rinderpest date back to its creation, its Global Rinderpest Eradication Programme (GREP) was established in 1994 with the ambitious goal of coordinating efforts worldwide. GREP brought together not only scientific resources and talent but also international cooperation and the financial will—approximately $5 billion—that would be needed to defeat rinderpest.

While there had been many attempts of varying success to control the disease in the hundreds of years prior, GREP was able to mobilize efforts and resources on a scale not seen before and guide use of key scientific advances that made eradication possible. Specifically, in partnership with the International Atomic Energy Agency, the FAO mobilized resources to develop a rapid diagnostic field test that is as simple to use as a home pregnancy test. Additionally, the FAO and partners working in the field evaluated the efficacy and safety of a vaccine developed in the United States that is heat-resistant and able to survive for a month without refrigeration. In some of the world’s hottest climes, this vaccine remained effective, allowing hundreds of thousands of animals to be treated.

In conjunction with restricting the movement of susceptible animals, quarantines and, in some instances, elimination of infected animals (and the animals they had come into contact with), countries were able to devise strategies that were culturally and geographically appropriate to rein in rinderpest. Year by year, and at an accelerated pace after 1998, the range of rinderpest continued to shrink.

The last-known outbreak was in 2001 among wild buffalo in Kenya's Meru National Park. The last use of vaccine is believed to have been in 2006 in Central Asia. After nearly 10 years of widespread disease monitoring in remote areas of Asia and Africa, says Lubroth, it was determined that the disease was no longer circulating.

Remaining vigilant

Though rinderpest has been declared eradicated in the wild, the virus continues to exist in laboratories in some 30 countries.

The FAO and its international and regional partners are continuing to assist countries in safely disposing of the virus samples or transferring them to a few biologically secure storage facilities, as has been done with smallpox samples. However, virus samples and virus stocks or vaccines could prove necessary should rinderpest reappear from either an unknown source, such as a reservoir species, or the deliberate or accidental release from a holding laboratory. Thus, the FAO continues to monitor for rinderpest in wildlife and livestock.

In addition, the long experience of battling and defeating rinderpest needs to be conserved in veterinary and medical health curricula as a model for combating the growing number of diseases that pose threats not only to animal health but also to humans.

"We have to be sure that veterinarians of the future do not forget about rinderpest," says Lubroth. "The lessons learned can be applied to other devastating diseases, such as foot-and-mouth disease, which in the U.K. alone caused more than $25 billion in economic losses during an outbreak 10 years ago."

Lubroth directs the FAO's global responses to other major livestock diseases, such as foot-and-mouth disease, swine fever, Rift Valley fever and avian influenza. In the age of globalization, he notes, "we can circumnavigate the globe in less than an incubation period. We saw that with SARS in China, Singapore and Canada. The only thing faster is information. In theory, we can share information faster than an incubation period, but we need to do better in practice."

Monitoring tools and having people on the ground to track diseases are costly, he notes, but in the grand scheme of things, $5 billion to eliminate a disease is a relative bargain when the billions of dollars in economic gains that trickle down to so many people are taken into consideration, says Lubroth. It is better to tackle problems early on rather than waiting for a disease to affect three continents and then mount a global response. "It's like trying to fix something once it's already broken," he says. "We should instead be investing in the routine care and maintenance that avert total disaster in the end.

Looking forward

Future disease initiatives are focusing on peste des petits ruminants (PPR) and foot-and-mouth disease, Lubroth says. PPR belongs to the same genus as rinderpest, occurs in the same regions of the world and requires similar diagnostic tools, and a PPR vaccine already exists.

Yet it afflicts mainly goats and sheep, raised by poorer segments of society and of less economic value to global trade, so the political will to target PPR for elimination is currently lacking. However, the FAO is gathering information to convince international donors that PPR and other existing disease threats are beatable if a long-term commitment is made.

But Lubroth also signals a word of caution: rather than target the next disease to be eradicated, the international community should address the underlying factors that drive the emergence of new and re-emerging disease threats. And the number of new threats is skyrocketing, far outpacing vaccine development for any particular disease.

By applying the principles of what is known as "one health," Lubroth says, the scientific community can minimize factors that propagate new disease threats in the first place. The idea of one health is that the health of animals and that of both humans and the ecosystems that support them are all inextricably linked. The knowledge of the scientific experts in each of these traditionally distinct disciplines converges into a united force to maintain health.

Avian influenza, for example, is being tackled in just this way: by studying and analyzing the socioeconomic factors that contribute to the disease's lasting foothold in a number of countries, looking at the risks to and from wildlife, as well as factors such as hygiene, livestock production practices, expanding animal and human populations and environmental encroachment.

Taken together, these modern pressures create a tinderbox for diseases that can be a risk to everyone's health. Avian influenza, in particular, poses the constant threat that it will make the leap to humans, where it could become much more lethal. So combating disease at its source is the key to preventing a global human pandemic.

The health of one, Lubroth notes, is the health of all.

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