War on Cattle Disease Divides the Troops

Eradication of rinderpest in Africa is aim of an international campaign, but there is skepticism that the goal can be achieved soon and some agencies are not participating

In Ethiopia, it has been the custom to designate the years by major events such as an emperor's birth or a decisive battle. A century ago, one very bad year for the country was commemorated as the Year of the Annihilation of Cattle. A virulent disease new to the region was apparently brought in by cattle imported as part of an Italian invasion attempt in 1889. Within a decade, rinderpest, German for cattle plague, swept the length of the continent. Records are unreliable, but the disease seems to have killed up to 90% of the cattle in a part of the world where herding provides a way of life and a means of survival. Susceptible wild animals—mostly ruminants in the huge herds on the African plain—were also decimated. Since then, rinderpest has been the principal killer disease of livestock in Africa.

This month, a vaccination campaign against rinderpest is scheduled to begin in five African countries* with the aim of eradicating the disease worldwide. Later phases of the campaign, an international venture, will be mounted in South Asia and the Middle East, where the disease is also endemic. Africa, however, offers special problems. Perhaps the most perplexing is that the continent's wild animals—buffalo, wildebeest, giraffe, and warthogs are usually mentioned—are suspected of providing a reservoir of rinderpest infection.

Proponents of the campaign insist that the weight of evidence indicates that comprehensive vaccination of domestic animals will lead to eradication of the disease. Uncertainties on this score remain, however, and there are other unanswered questions about transmission of the disease.

A more immediate threat to the campaign, however, is armed conflict in places like southern Sudan and along the Ethiopia-Somalia border that could prevent vaccination of animals in those areas. According to Y. Ozawa, the chief of animal services for the United Nations Food and Agricultural Organization (FAO), "The real concern is not wildlife, the real concern is war."

Political and logistical problems, therefore, have combined with technical questions to cause a division in the ranks of international development organizations about the strategy for fighting rinderpest. The differences over strategy are not about whether eradication of rinderpest is possible, but whether it should be attempted now. The rinderpest vaccination campaign, in fact, may offer a textbook example of technology that works in industrial countries faltering in African conditions.

The opening phase of the campaign in Africa, called the Pan-African Rinderpest Campaign (PARC), will be conducted under the banner of the Organization of African Unity. FAO is organizing the financing and providing technical support. Funding is coming mainly from the European Community, which has put up more than $50 million.

The U.S. Agency for International Development (USAID) declined to participate in PARC, electing to concentrate its efforts on rinderpest on developing improved vaccines. The World Bank continues to express firm reservations about the campaign.

There is no dispute about the seriousness of the disease. Rinderpest is a virus of the *Morbillivirus* group that causes measles in humans and canine distemper. A highly contagious disease in cattle, rinderpest causes high fever and inflammation and lesions of the respiratory and alimentary tracts. It kills in a few days. Even in regions where repeated outbreaks of the disease have allowed resistance to develop, it is fatal to 50% or more of the animals who contract it and weakens those who survive.

There is also no disagreement about the effectiveness of the vaccine designated for the campaign—an attenuated live virus vaccine introduced in the early 1960s—when it is properly used. The rinderpest virus is relatively tractable in the sense that all strains are immunologically homogeneous and vaccine based on one strain gives protection against all strains. A single dose of the Plowright vaccine, as it is called, immunizes for life, there are no adverse effects, and the animal does not carry the virus after vaccination. The catch is that the vaccine is sensitive to sunlight and requires that the "cold chain"—refrigeration—be unbroken from the point of production virtually to the moment it is used in the field. In Africa, the protocols are too often broken.

Ironically, the high regard in which the vaccine is held probably helps to account for lack of interest in the industrial countries in

FAO

Rinderpest symptoms. *In Sudan, FAO veterinarian examines cow with runny eyes and lesions on the mouth that are indicators of deadly viral disease.*

*Burkina Faso, Ethiopia, Mali, Nigeria, and Sudan.

exploring the epidemiology and the biology of transmission of rinderpest. Rinderpest was long ago eradicated in the United States. The U.S. Department of Agriculture (USDA) Plum Island Animal Disease Center's mission is to ensure that diseases such as rinderpest do not occur here. Given the availability of a reliable vaccine and the high standards of veterinary services and animal hygiene in the United States, Europe, and Japan, rinderpest is unlikely to be a problem in these countries. So research on rinderpest is not a high priority.

An earlier try at a comprehensive vaccination campaign in Africa, known as Joint Project 15 (JP-15), was conducted with international backing between 1961 and 1976. The disease was cleared from many areas, but in 1979 outbreaks occurred in Mali, Mauritania, and Senegal, and rinderpest spread rapidly in West Africa. A similar resurgence of the disease began in East Africa in the early 1980s after it reappeared on the Ethiopia-Sudan border.

The outbreaks peaked in 1983, checked by local vaccination campaigns. Ozawa says that precise figures are unavailable but that direct losses in the 1980–1984 period are estimated at $400 million and indirect losses from effects on the economy at about $1 billion.

Rinderpest is particularly hard to control in Africa because the movement of nomadic herds over long distances abets its spread. Crucial also is the near collapse of the national livestock services in many African countries, making them unable to carry out an effective vaccination program or the follow-up activities that are essential to prevent recurrence of the disease.

Dealing with nomadic herdsmen presents its own difficulties. Pastoralists in most African countries form minorities with little political power who historically have had poor relations with governments and are mistrustful of government officials. If an outsider appears to be making a head count at a cattle dip or other assembly area, the nomads are likely to suspect he is the tax man and vanish over the horizon.

Most pastoralists are adept at spotting livestock diseases and dealing with the less serious ones. If rinderpest threatens their herds, they do seek help from the national veterinary services. When an outbreak subsides, however, they tend to shy away again.

The demands of vaccinating on the African range can hardly be overstated. A first-hand witness is Tilahun Yilma, now a professor of virology at the University of California, Davis, and head of a USAID-sponsored project to develop a genetically engineered rinderpest vaccine. Yilma, who was born in Ethiopia, completed veterinary school in this country and worked in Ethiopia on the JP-15 campaign.

In the field, Yilma says there are three main problems. After vaccines are transported long distances in 100-degree weather, "You may be giving deactivated vaccine," says Yilma. Vaccinating half-wild, unpenned cattle which often start fighting when they are herded together can easily result in botched vaccinations. And, because calves under 6 months old are protected by maternal immunity that can neutralize the vaccine, it is necessary to vaccinate each herd for at least two successive years.

PARC is designed to take these factors into account. At an international veterinary meeting in Montreal in August, Ozawa acknowledged that harsh climate and vast distances make safe delivery of vaccine and disease surveillance difficult in Africa. He identified budgetary problems as "the main cause of the breakdown of state veterinary services in the majority of African countries," and said, "In those countries, therefore, emphasis should be given to the rehabilitation of veterinary services and the restructuring of livestock services." In other words, most of the 28 African countries involved in PARC will need substantial financial assistance from donor countries to participate.

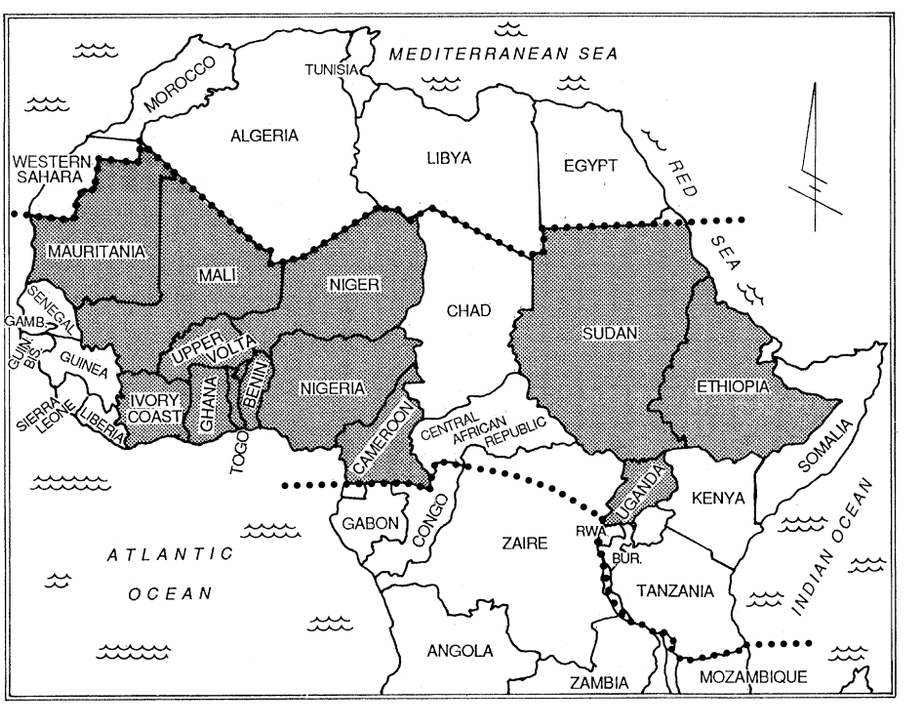
PARC is to be organized into regionally coordinated national campaigns. Each country's territory will be marked off into enzootic areas, sanitary-cordon areas, and rinderpest-free areas. Vaccination and surveillance phases will be carried out for appropriate periods in each area. A national campaign is expected to last about 7 years and to be succeeded by international monitoring.

PARC planners are putting strong emphasis on the follow-up to the campaign. In an interview with *Science*, Ozawa said this was not given adequate attention after the last comprehensive campaign. Ultimately, some herds will have to be quarantined and animals destroyed. To ensure that suspected cases of rinderpest are reported, for example, it will be "necessary to offer compensation for the destruction of herds."

The PARC plan also provides for research to explore the lingering questions about rinderpest. At the Montreal meeting Ozawa said, "Although it is believed by many scientists that rinderpest in the wildlife population will die out if domestic animals (mainly cattle) in Africa are properly vaccinated, further studies are needed to understand the epidemiology of the disease, in particular the possible role of associations of game and domestic animals, including small ruminants, in maintenance of the virus."

There are two main issues. Can wild animals serve as a reservoir for rinderpest in cattle? Can the disease be transmitted by small ruminants, namely, the goats and sheep frequently mixed with cattle in the pastoralists' herds?

Walter Plowright, developer of the rinderpest vaccine that carries his name, stays abreast of research on the disease and serves as a consultant to the PARC planners. Plow-



Drawn by Eleanor Warner

Dotted lines enclose planned area of rinderpest vaccination campaign. Shaded area indicates where sporadic outbreaks occurred in 1985–1986.

right says that, "In Africa there is no substantial evidence that sheep and goats serve as a long-term reservoir." In India, there have been signs of the virus in such animals, he says, "but the evidence is controversial."

A complicating factor with respect to sheep and goats is that they are susceptible to a rinderpest-like disease known as PPR for its name in French, *peste des petits ruminants*. Jerry Callis, director of Plum Island for 24 years and now a senior scientific adviser there, says it is not clear whether PPR is rinderpest in sheep and goats or another virus. "We have not looked at PPR at the molecular level. We have the tools to do it, and I think the relationship of PPR to rinderpest should be sorted out." The result should throw light on whether sheep and goats should be immunized; they are apparently protected by the Plowright vaccine.

As for the possibility that game animals in Africa are implicated, Plowright says that "in such evidence as has been produced—for example, African buffalo—there is no strong indication that those animals provide a long-term reservoir in the absence of a disease reservoir in cattle." Callis cites the argument that if cattle are vaccinated comprehensively, the disease "will burn itself out," and says, "There is quite a bit of evidence that that is the case."

Plowright says he thinks prospects for eradication of rinderpest by the present campaign are favorable, but attaches "one proviso": frequent vaccination. With animals that reproduce as frequently as cattle, large numbers of new animals are added each year, and protection can be maintained only by annual revaccination, says Plowright.

"It is technically feasible to eradicate rinderpest," says Callis, and he applauds the international effort. "But it's going to be a long way from the beginning to the end. Eradication is going to test the endurance of the people engaged in it—physical and fiscal."

From the start of discussions on the rinderpest campaign, the World Bank has questioned the form and objectives of the effort. The bank was not a potential donor to PARC, which does not fit the bank rule that it make loans only for specific development projects. But the bank is represented on the committee that guides PARC and bank analyses tend to influence other donors.

Poul Sihm of the bank's technical staff says that bank objections centered on the weakness of the African veterinary services and inaccessibility of areas where there was civil strife. Sihm, a veterinarian with experience in Africa, says the bank also took into account the "question mark" over whether game animals represent a reservoir of the disease and the rumblings about PPR. He says that the bank is still arguing that "you can't eradicate rinderpest as distinct from controlling it. But you need to go on doing fire brigade work."

Among informed U.S. government officials and university researchers there seems to have been little enthusiasm for American participation in PARC. Harless McDaniel, assistant director of policy planning for international development in the USDA's Animal and Plant Health Inspection Service, says his personal view is that this reluctance is based on experience with the earlier campaign. At first, "JP-15 was looked on as a tremendous success," says McDaniel. "USAID and other development agencies made a big effort. But they kept vaccinating for years and it didn't work."

The official USAID position is that because other donors had been lined up to fund the vaccination campaign, USAID decided that it could make the best use of limited funds by trying to develop improved vaccines. As part of this effort, USAID is supporting development of a thermally stable vaccine for rinderpest at Tufts University School of Veterinary Medicine. The project is part of a USAID-sponsored livestock project in Niger in West Africa.

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The agency is also backing a project to develop a rinderpest vaccine by bioengineering techniques. The goal is a vaccine made by inserting rinderpest genes into vaccinia virus, the virus used for human smallpox vaccination.

The principal investigator, Tilahun Yilma at Davis, says that extraction of viral RNA was done at USDA's Plum Island center off Long Island, the only facility in the United States permitted to work with exotic animal viruses. Cloning the rinderpest genes that code for the surface protein of the virus was carried out with scientists from California Biotechnology in Mountain View, California. Development of the vaccine is being done in Yilma's laboratory. Initial evaluation of the vaccine on animals will be done at Plum Island and detailed testing at the Agricultural Research Foundation in Kenya.

Not only would a genetically engineered vaccine be stable at room temperature, making it much less dependent on the cold chain, but also it offers the prospect of herdsman being able to produce and administer their own vaccines. Yilma says that this should be done under supervision to guard against the transmission of other diseases, but, once a recombinant vaccine is available, it should be possible to scratch the skin of a calf, seed the wound with the vaccinia virus, collect and grind the scabs, and prepare a filtrate that could be used as vaccine.

Yilma says that extreme caution is being exercised in the project. Not only does the general uneasiness about the introduction of genetically engineered life forms into the environment pertain, but doubts have been expressed about the use of vaccinia virus. Some observers have speculated that the increasing incidence of AIDS in Africa means that numbers of people with suppressed immune systems could be vulnerable to infection with vaccinia virus shed by vaccinated cattle. Yilma says that research focused on the issue has discounted the threat. He says, moreover, that effective steps can be taken to minimize such a possibility by further attenuating the virus.

On behalf of PARC, FAO is also supporting work on new vaccines and faces the same questions. Hardly mentioned, however, is another sort of environmental problem that will be produced if the rinderpest eradication campaign succeeds. As one U.S. scientist put it, "What happens when you have all those cows in Africa?" Overgrazing, particularly in the dry zones of Africa, has caused severe damage to the environment, and eradicating rinderpest could accelerate the already rapid increase in livestock numbers.

PARC planners are aware of the problem. Ozawa in Montreal said, "To avoid desertification of land due to overstocking in certain countries as the result of successful campaigns, improved animal production systems should be planned and introduced by livestock services in partnership with the governments concerned."

The record in Africa provides little cause for optimism on this score. The sponsors of the rinderpest campaign, however, have obviously chosen to focus on the undoubted importance of the estimated 120 million cattle owned by pastoralists and smallholders in the region and the improvement in economic and social stability that a victory over rinderpest would bring.

The next decade will show whether FAO, the European Community, and their African partners can muster the will and resources to eradicate rinderpest in Africa. Whatever the outcome, the attempt itself could have some important benefits. As Roger Breeze, the new director of Plum Island, notes, "Building up their veterinary services may be the most important thing that comes out of the campaign." ■ **JOHN WALSH**