



THE  
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CASE STUDY

Impact Hub Case Study:  
**APOPO Deploys Rats at Scale to  
Find Landmines and Tuberculosis**

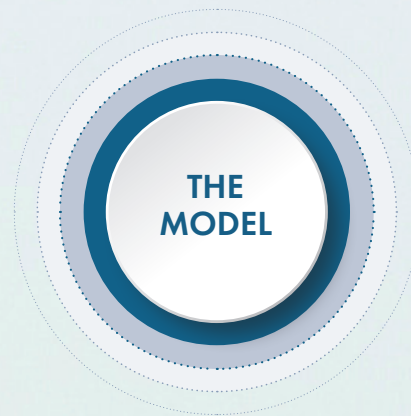
By Charlie Euchner



Landmines left over from wars kill and injure thousands of people every year; tuberculosis kills more than 1 million, in part because of poor diagnostic capacity.



Using trained scent-detection rats to identify landmines in post-conflict zones and to more quickly and accurately diagnose tuberculosis cases in the world's poorest areas.



A lean and nimble team works with networks of partners to integrate its detection rats into demining and tuberculosis diagnostic operations worldwide.

At the end of every war, a new struggle begins. The people who live in post-conflict zones must contend with lethal leftovers, including landmines. Landmines are among the most barbaric weapons of war because they continue to kill and maim innocent people long after the war itself has ended," former United Nations Secretary General Kofi Annan once remarked.

Various methods have been used to detect and remove landmines, from human sweepers to massive plows that dig up buried explosives. Most of these approaches are inefficient, expensive, or risky. Metal detectors often turn up false positives, since not all metal objects are mines. Plows can cause unintentional explosions. And human-conducted searches put surveyors at risk.

Into this breach, a Belgium-based nonprofit called APOPO (a Flemish acronym that means Anti-Personnel Landmines Detection Product Development) has developed a novel technique for identifying landmines: rats. The organization trains African Giant Pouched Rats to use their powerful sense of smell to detect explosives under the ground. Too light to trigger a blast, the rats skitter across minefields and scratch the ground wherever they smell a trace.

After demonstrating success using rats to find mines, APOPO expanded its mission to address another hidden threat detectable by the animals' sense of smell: tuberculosis. Though easily treatable, the

respiratory disease kills more than 1 million people each year, more than any other infectious disease other than COVID-19, primarily because of inadequate diagnostics in poor areas. Trained rats can sniff out the presence of tuberculosis in a human sample more quickly and accurately than a lab technician can identify it using a microscope.

APOPO was founded in 1997 by a product designer named Bart Weetjens and Christophe Cox, a professor at Antwerp University.

*APOPO is lean and nimble, with an annual budget of less than \$9 million. In order to develop and implement its method at scale, the organization has relied on an extensive network of partners worldwide, ranging from national governments to universities to local communities.*

In 2023, APOPO was carrying out its mission in 12 countries. From its founding to 2022, APOPO says it has cleared more than 160,000 landmines and other unexploded ordinances, and it has detected more than 27,000 additional cases of tuberculosis.<sup>1</sup> In so doing, it has used an unlikely technology – rats – to improve the lives of some of the world's most vulnerable people.



### Key Lessons

- To scale a novel, effective technology and method, collaborate with partners and their existing projects and programs.
- Manage operations at the local level, in close partnership with affected communities.
- To build credibility at all levels, demonstrate results and engage key institutional gatekeepers.



An APOPO rat detects tuberculosis samples at a facility in Tanzania, © APOPO.



## The Problem

**Landmines** imperil people in more than 60 countries that had or are currently experiencing conflict. Experts estimate that at least 110 million landmines are in the ground.<sup>2</sup> In 2021, there were more than 5,000 fatalities and some 20,000 injuries caused by landmine accidents worldwide. Half of those accidents involved children.

Even a small number of mines can make a whole area unusable. In addition to being a hazard to life and limb, mines are a major barrier to development. Mines prevent farming, the construction of roads or

settlements, the delivery of government services, and other livelihood-supporting activity.

Detecting and removing mines is expensive and can take decades. It requires technical skills and resources that can exceed the capacity of communities to carry out for themselves. According to APOPO, it costs as little as \$3 to make a landmine. Yet finding and removing one using a human minesweeper can cost between \$300 and \$1,000.<sup>3</sup> Human searches are inefficient, as metal detectors identify non-explosive pieces of metal, as well. And the work is dangerous: several die or are injured each year.



An APOPO rat searches a minefield, © APOPO.

**Tuberculosis** may seem like a vastly different problem than landmines. Yet the two have similar features: both afflict some of the world's poorest and most vulnerable communities, both have straightforward solutions, and the core challenge for both is detection.

In 2022, 1.3 million people died from tuberculosis, more than from any other infectious disease besides COVID-19. Tuberculosis is easily treatable. In countries with developed health systems, the disease is no longer a problem. But in poor areas, especially in sub-Saharan Africa, a lack of diagnostic capacity

means that many cases go undetected, allowing the disease to spread. Of the more than 10 million people infected each year, 3 million go undiagnosed.

Tuberculosis can be difficult to diagnose, since its symptoms resemble those of the flu, pneumonia, and other respiratory illnesses. The means of diagnosis—like the tuberculin skin test, chest X-rays, and tests of sputum, the material that comes up from the air passages when one coughs deeply—are not always reliable or available in communities with limited resources.



A doctor listens to the lungs of a patient, © APOPO.



## The Method



A handler with the Cambodia Mine Action Center prepares to deploy a rat in a minefield, © APOPO.

As a child growing up in Belgium, Bart Weetjens got a pet hamster. The creature fascinated him. Before long he was breeding rodents of all kinds for pet stores. As an adult, he took an interest in the devastation wrought by wars in Africa and Asia. After reading a publication detailing the use of gerbils as scent detectors, he wondered if rats could be trained to find landmines.

Working with Christophe Cox, a former schoolmate who had become a professor at Antwerp University and other faculty at the university, Weetjens began exploring the idea. They determined that the best species would be the African Giant Pouched Rat, which has a lifespan of around eight years, relatively long for a rat, and is native to Africa, where the researchers determined their demining work would begin.

The rats are affordable to breed, train, and maintain. They eat simple food—usually bananas and peanuts or peanut butter—that is available anywhere. Their small size means they are easy to transport. A standard sport utility vehicle can carry a dozen at a time.

In 1998, a year after founding APOPO with a grant from the Belgian government, Weetjens and Cox bred their first bomb-sniffing rat. After eight months of tests, they concluded that the rats could accurately detect buried explosives. In 2000, they moved their operation to Tanzania, where they established a training center with rat kennels and training labs and fields. APOPO first began clearing mines in Mozambique, followed by other countries in sub-Saharan Africa and Southeast Asia.

### Demining

*An APOPO operation often begins by consulting local communities to prioritize areas for demining.*

The determining factor is how much people want to use an area for transportation, farming, and other vital purposes, said Michael Heiman, a regional manager who has overseen APOPO's Cambodia operations since 2018. "People are afraid to go up to a certain mountain or to a certain valley because somebody

had an accident there," he said. "It doesn't really matter how many mines you're going to find. What matters is how big is the area where people are afraid to go. So, it's basically how many square meters of land are actually blocked by people afraid to get in."

APOPO teams partition these areas of land into "polygons," sections that can range from 1,000 to 200,000 square meters. The rats are then brought in to identify the precise location of the mines.

Two methods are used to guide the rats to sniff a plot of land.<sup>4</sup> In the first, a single handler will hold a long, lightweight pole, at the end of which a short tether connects to the rat. The rat will sweep a half-meter front and indicate any potential mines. After those indications have been checked, the handler will advance to the next half-meter section.

In the second method, two handlers stand opposite one another, each in a one-meter-wide lane. Between them is a 10-meter by 20-meter box. The two handlers hold either end of a lightweight rope, to which the rat is attached by a harness and short cable. The rat walks the length of the rope from one handler to the other, sniffing for mines. Once it reaches the edge of the box, the two handlers both take a sideways step, and the rat turns around and heads back down the length of the rope to clear the new stretch.

Starting in 2017, APOPO also began training Technical Survey Dogs to complement the rats, which are too small to cover terrain that is rocky or overgrown with thick vegetation. Belgian Shepherds (Malinois) equipped with a GPS tracker, smartphone camera, and a loudspeaker so the dog can hear commands from its handler, survey areas up to 4,000 square meters to identify mined zones. Too heavy to walk over heavily mined territory, when a dog detects a landmine, it sits one meter from the mine and points toward it with its nose; according to APOPO, none of their dogs have ever been hurt or killed by a landmine.

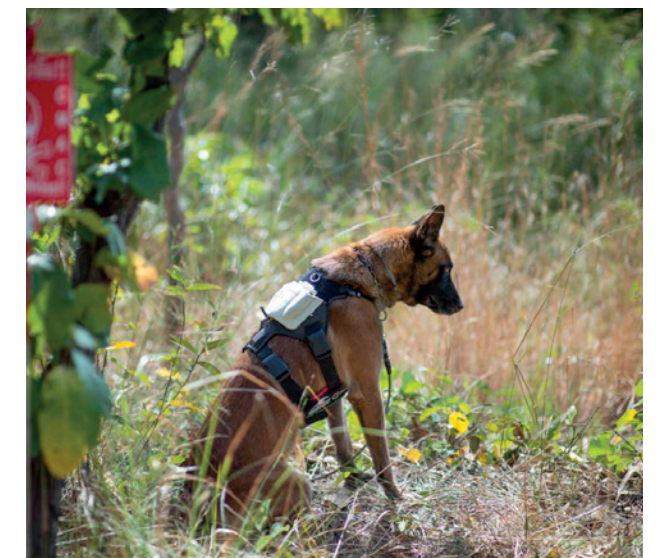
The rats and dogs are quicker and more affordable than other methods of mine detection, in part because they ignore the scrap metal that is often littered among minefields. "We have by far the most cost-efficient price per square meters: 15 cents. Other organizations are at least five to ten times as expensive," Cox said.

### Tuberculosis Detection

Shortly after APOPO moved to Tanzania, the organization began wondering if scent-detection rats could be used for other humanitarian challenges. One of these was tuberculosis, which was widespread in the area, primarily because of inadequate detection.

In 2003, APOPO expanded its mission to include detection of tuberculosis in Tanzania and later Ethiopia. The method involves working with local health clinics, which collect sputum samples from patients who come in with potential tuberculosis symptoms. Typically, a lab technician would analyze the samples using a microscope to identify the presence of the bacteria. In many poorer regions with limited health system capacity, the analysis can take a long time and positive samples can be missed. Meanwhile, the patient is back in the community spreading the disease.

Trained rats are able to quickly detect the bacteria by scent. APOPO couriers collect samples from clinics and bring them to a central lab, where rats sniff the samples. According to APOPO, a single rat can check 100 samples in less than 20 minutes, work that would take a lab technician 4 days using microscopy. When rats indicate the presence of tuberculosis, lab technicians confirm the results, which are reported back to the clinic. The clinic contacts patients to inform them of the diagnosis. In some cases where the patient cannot be quickly reached, APOPO dispatch community workers on motorbikes to carry the news from the hospitals to the patients.



A technical survey dog sits and points to a mine in the field, © APOPO.

## The Model - Partnerships

APOPO's technology – scent-detection animals, rats especially – is accurate, affordable, and fast. In order to scale the use of that technology to solving these humanitarian challenges, APOPO works through partners. It deploys its rats and methodology through existing demining and tuberculosis detection programs run by governments, multilateral organizations, and NGOs.

APOPO itself is a lean organization. Its administrative office in Belgium has only one permanent staff member, and APOPO uses less than 15 percent of its resources for administration and marketing combined. "We don't have a lot of extras," said APOPO co-founder and CEO Christophe Cox. APOPO's operations are managed locally and rely on partnerships with local NGOs, public institutions, and communities in the places where it works.

Where it operates, APOPO nonetheless works closely with national, regional, and local governments, as well as other international demining organizations. The nature and extent of collaboration varies by country. In Cambodia, where APOPO has its largest demining footprint, the organization's operations are integrated with those of the Cambodian Mine Action Center, a governmental institution that leads the country's mine clearance activities. In Zimbabwe, APOPO works more independently, tasked by the government to clear a large minefield in the Sengwe Wildlife Corridor on the border with Mozambique that threatens both local communities and endangered animals that transverse the area.

In 2015, APOPO established a foundation to develop and centralize fundraising for the organization's work. Governments including the United States, Switzerland, and Japan, as well as philanthropies and corporations have all been donors. Multilateral agencies such as the United Nations Development Programme (UNDP) also have provided programmatic funding and contracted APOPO to support mine clearance projects.

Engagement and partnerships with the international organizations that comprise the global demining community have been essential for APOPO to build credibility and scale the use of its technology. It works with advocacy groups such as the International Campaign to Ban Landmines and the Mines Advisory Group. International and national demining standards and accreditation organizations have continually evaluated, licensed, and provided feedback on the efficacy of APOPO's technology and work. The most prominent of these has been the Geneva International Center for Humanitarian Demining, an international nonprofit founded by governments.

Finally, in almost all of its work, APOPO has worked closely with community members and poor and vulnerable populations living in mined areas. APOPO provides education to communities about safe practices around mined areas and to identify potential leaders and specialists. In addition to consulting with local communities during its work, APOPO has hired many project workers locally.





## The Model - Demonstrating Results and Building Credibility

APOPO's technology is both unconventional and, to many, viscerally repelling. Few animals are as maligned and disliked as rats. As a result, APOPO has had to overcome skepticism to demonstrate the effectiveness of the method and build credibility in the global demining and health communities. According to APOPO's leaders, in its early years, the organization faced criticism from established organizations that questioned the use of novel methods when traditional demining efforts were already underfunded. Fundraising was a challenge.

APOPO built credibility and won over critics and funders in several ways. First, it validated its methods with scientific studies. In 2003, it conducted its first and what would prove to be most important trial in Mozambique, where APOPO's rats located all 20 mines in a minefield. The results were published in *The Journal for Mine Action*, drawing the attention of the demining community.<sup>5</sup> Similarly, APOPO demonstrated the viability of its tuberculosis detection method and built credibility among the health community by publishing its findings in the *International Journal of Tuberculosis and Lung Disease* in 2009.<sup>6</sup>

APOPO also has undergone evaluation by trusted external parties. Its demining work has been reviewed by the Geneva International Center for Humanitarian Demining and national accreditation bodies, such as the National Demining Institute in Mozambique. Evaluation ensures compliance with international certification standards, and APOPO says the feedback provided by evaluators has helped it to continually improve its detection methodology.

APOPO first proved the effectiveness of its approach in Mozambique, where it carried out its first mine clearance operations. Tens of thousands of landmines had been set during the country's independence war against the Portuguese (1964-1974) and subsequent civil war (1977-1992). From 2008 to 2012, APOPO cleared more than 6 million square meters of land, contributing to the country being declared mine free in 2015.

Yet it was not until APOPO began working in Cambodia that it gained attention as a leading hub for demining operations. Cambodia has been perhaps the country most devastated by landmines. Millions were planted throughout the country's 30-year civil war (1968-1998). From 1979 to 2022, an estimated 20,000 people died in landmine accidents; 40,000 of the country's 16.6 million people are amputees.<sup>7</sup>

"You need a few good demonstrations," Cox, the CEO, said. "That's why Cambodia was so important. The demining community, they all come to Cambodia. Then they come to the ground and see what we are doing." APOPO began collaborating with the Cambodian Mine Action Center in 2014 and first deployed rats in 2015. In 2022, the two organizations agreed to continue that collaboration.

*"You can develop a technology, but efficient implementation is another thing," said Cox. "It's a long journey of trial and error, a fight for 20 years to survive. Now with the maturity of the technology and the team and the partnerships, we have developed trust and a record."*



A mother and daughter tend to a field that had been cleared of mines, © APOPO.



## The Impact

From its founding in 1997 to the end of 2022, APOPO reported that it cleared more than 87,000 square kilometers of land and destroyed more than 155,000 explosive devices. It estimates that 2.2 million individuals are able to live safer lives as a result.<sup>8</sup>

During that same period, APOPO reported that in Ethiopia, Tanzania, and Mozambique it screened more than 500,000 potential tuberculosis patients, identifying more than 27,000 additional cases that would not have been detected otherwise, preventing as many as 270,000 infections.<sup>9</sup>

External evaluations have detailed the savings in cost and time afforded by mine-detecting rats. In a 2016 report, the Geneva International Center for Humanitarian Demining found that operations using APOPO rats in Angola and Mozambique cleared land in about 70 percent of the time that would be used with traditional methods.<sup>10</sup>

The report also concluded that mine-detecting rats were especially useful “in areas where mechanical assets are limited in mobility and in areas contaminated by metal scrap and fragmentation, which would severely affect the use of mine detectors. Furthermore, the system effectively reduces false indications compared to traditional mine detectors since they only indicate an explosive scent.”

The broader, longer-term impact of APOPO’s work is harder to measure. After land is cleared and released back to the community, economic activity and quality of life can improve. And the demining campaigns themselves boost livelihoods and opportunities. According to Heiman, many of the local community members APOPO hires or engages in its operations develop skills and experience that go beyond the technical competencies of the job.

“When they join, some of them don’t know how to read or write,” Heiman said. “They are very shy, usually very skinny, and have lived a hard life.” But in working with a demining team, many build confidence, English language competency, and leadership, he said.

*The ultimate goal of the work is bigger than mitigating risk to physical safety. “It’s not enough to clear the land,” said Heiman. “We want the real outcome to be a better life.”*



A handler trains a mine-detection rat, © APOPO.

## References

<sup>1</sup> <https://apopo.org/what-we-do/detecting-landmines-and-explosives/impact/>

<sup>2</sup> <https://landminefree.org/facts-about-landmines/>

<sup>3</sup> <https://apopo.org/what-we-do/detecting-landmines-and-explosives/about-landmines/>

<sup>4</sup> <https://commons.lib.jmu.edu/cgi/viewcontent.cgi?article=2355&context=cisr-globalcwd>

<sup>5</sup> JOURNAL, CISR (2006) “The Journal of Mine Action Issue 9.2 (2006),” *Journal of Mine Action : Vol. 9 : Iss. 2 , Article 1.* Available at: <https://commons.lib.jmu.edu/cisr-journal/vol9/iss2/1>

<sup>6</sup> [https://www.researchgate.net/profile/Sayoki-Mfinanga/publication/24444409\\_African\\_pouched\\_rats\\_for\\_the\\_detection\\_of\\_pulmonary\\_tuberculosis/links/00463528c6d52aa110000000/African-pouched-rats-for-the-detection-of-pulmonary-tuberculosis.pdf](https://www.researchgate.net/profile/Sayoki-Mfinanga/publication/24444409_African_pouched_rats_for_the_detection_of_pulmonary_tuberculosis/links/00463528c6d52aa110000000/African-pouched-rats-for-the-detection-of-pulmonary-tuberculosis.pdf)

<sup>7</sup> <https://iime.com/6304901/cambodia-land-mine-found-school/>

<sup>8</sup> [https://apopo.org/wp-content/uploads/2023/06/APOPO\\_annual-report-2022-final.pdf](https://apopo.org/wp-content/uploads/2023/06/APOPO_annual-report-2022-final.pdf)

<sup>9</sup> [https://apopo.org/wp-content/uploads/2023/06/APOPO\\_annual-report-2022-final.pdf](https://apopo.org/wp-content/uploads/2023/06/APOPO_annual-report-2022-final.pdf)

<sup>10</sup> <https://commons.lib.jmu.edu/cgi/viewcontent.cgi?article=2355&context=cisr-globalcwd>



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