

Reaching the last mile

Eliminating onchocerciasis and lymphatic filariasis



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Introduction

SECTION I

PURPOSE AND AUTHORS

Context

The END Fund commissioned Dalberg to create this report to support the Reaching the Last Mile Fund's efforts to eliminate onchocerciasis (oncho) and lymphatic filariasis (LF) in its focus countries. This report aims to (i) employ a holistic methodology to estimate the main economic effects of eliminating these two diseases, (ii) illustrate the primary benefits of their elimination, and (iii) mobilize resources to achieve elimination in focus countries.

About the organizations

The END Fund has a singular focus—to control and eliminate the five most prevalent neglected tropical diseases (NTDs) through a proven implementation model that is tailored to meet the needs of individual countries. The END Fund puts private capital to work, facilitating strong collaborative partnerships with governments, the private sector, and local implementers to advocate for innovative, integrated, and cost-effective NTD programs.

The Reaching the Last Mile Fund (RLMF) is a ten-year, multi-donor fund dedicated to the elimination of river blindness and lymphatic filariasis in seven countries: Senegal, Mali, Niger, Chad, Sudan, Ethiopia, and Yemen. Stewarded and managed by the END Fund, RLMF was initiated by His Highness Sheikh Mohamed bin Zayed Al Nahyan, the Crown Prince of Abu Dhabi, in collaboration with the Bill & Melinda Gates Foundation with additional support from a diverse group of philanthropic, corporate, and government funders.

Dalberg is a global group working to build a more inclusive and sustainable world where all people everywhere can reach their fullest potential. Dalberg partners with and serves communities, governments, philanthropic institutions, and companies throughout the world, providing an innovative mix of advisory, investment, research, analytics, and design services.

EXECUTIVE SUMMARY

Countries that eliminate oncho and LF create significant economic benefits that catalyze economic growth. For example, by eliminating oncho and controlling LF, Niger added an estimated USD 2.8 billion to its economy over the last 45 years. These benefits manifested at three main levels (i) patients were able to lead productive lives and save on out of pocket health expenditures, (ii) families of those affected (e.g., women that care of the blind) were released from the burden of caretaking and enabled to pursue education and job opportunities, and (iii) rural communities resettled productive lands around rivers, helping the whole country flourish.

On the other hand, failing to eliminate disease transmission creates risks that can hamper economic development, especially for the most vulnerable populations. Vectors can carry these diseases over long distances. Control efforts that do not end with elimination pose a grave danger of recrudescence not only for the country in question but also for its neighbors. Furthermore, because those most impacted by oncho and LF tend to be at the base of the economic pyramid, failure to achieve last-mile elimination can exacerbate existing inequality and drive more communities into poverty. Countries that fail to prioritize elimination and allow NTDs to reemerge could lose the economic benefits of past efforts and face the compounding costs of ongoing disease management.

The RLMEF calls on governments, donors, private sector actors, and NGOs to maintain and scale support to achieve elimination of oncho and LF in Chad, Mali, Niger, Senegal, Sudan, Ethiopia, and Yemen.

Governments

- **Main role:** Lead efforts for last mile elimination by investing resources, implementing plans, like the 2030 WHO road map, and leveraging the expertise of those (e.g., countries and multilaterals) that have eliminated NTDs in other contexts.
- **Potential benefits:** Countries can avoid significant disease management costs in perpetuity. For example, even though the oncho prevalence rate in Niger decreased from ~70% in 1970s to 0.02% in 2002, the country continued to spend on oncho control efforts. In 2012, the government spent USD 2.7 million (1.2% of the govt's total health spending) to continue last mile elimination efforts. Today, after declaring complete elimination, Niger can avoid this cost altogether. Further, elimination efforts strengthen rural health services by creating drug distribution networks that can be leveraged to address multiple government priorities, including gender equity, sanitation, and rural development. In addition, elimination can help attract investment and bolster productivity, improving the country's economic landscape.

Donors and multilaterals

- **Main role:** Provide resources, train local stakeholders to manage oncho and LF elimination efforts, and advocate for NTD elimination to other key stakeholders.
- **Potential benefits:** By achieving NTD elimination, donors and multilaterals can help improve the situation of some of the most vulnerable persons in poor countries. Moreover, this work can engender improvements in many key areas of social equity by

helping close the gender gap, improving child schooling, and strengthening the health sector's capacity to battle other diseases.

Private sector actors

- **Main role:** Continue to donate drugs to help eliminate oncho and LF in last-mile contexts, continue to research and innovate to find new and more effective ways to eliminate diseases (e.g., by developing a safe macrofilaricide), and provide financial resources to accelerate the progress of last-mile elimination programs.
- **Potential benefits:** Investments made in last-mile elimination are investments in a healthier workforce, a stronger brand, and more engaged and economically successful customers. These investments can also open access to key inputs, such as resource-rich land. Many leading multinational corporations working in these markets have committed to such strategic philanthropy.

NGOs

- **Main role:** Support the delivery of health services to last-mile communities, including through training in and assistance with data-collection and continuing to advocate on behalf of communities to raise awareness among national governing bodies and global stakeholders.
- **Potential benefits:** Like donors and multilaterals, NGO participation can bring relief to some of the most vulnerable populations in the world. Moreover, once these diseases are eliminated, NGOs can focus on other key priorities, such as rural productivity, gender equity, and land rights, to further improve the lives and livelihoods of impacted communities.

ACRONYMS

Acronym	Definition
APOC	African Programme for Onchocerciasis Control
CDD	Community Drug Distributor
CDTI	Community-directed treatment with ivermectin
FAO	Food and Agriculture Organization
GDP	Gross domestic product
GPELF	Global Programme to Eliminate Lymphatic Filariasis
LF	Lymphatic Filariasis
MDA	Mass drug administration
NGDO	Non-Governmental Development Organizations
NGO	Non-Governmental Organization
NTD	Neglected Tropical Disease
Oncho	Onchocerciasis
OCP	Onchocerciasis Control Programme
RLMF	Reaching the Last Mile Fund
UNDP	United Nations Development Programme
WASH	Water, Sanitation, and Hygiene
WHO	World Health Organization

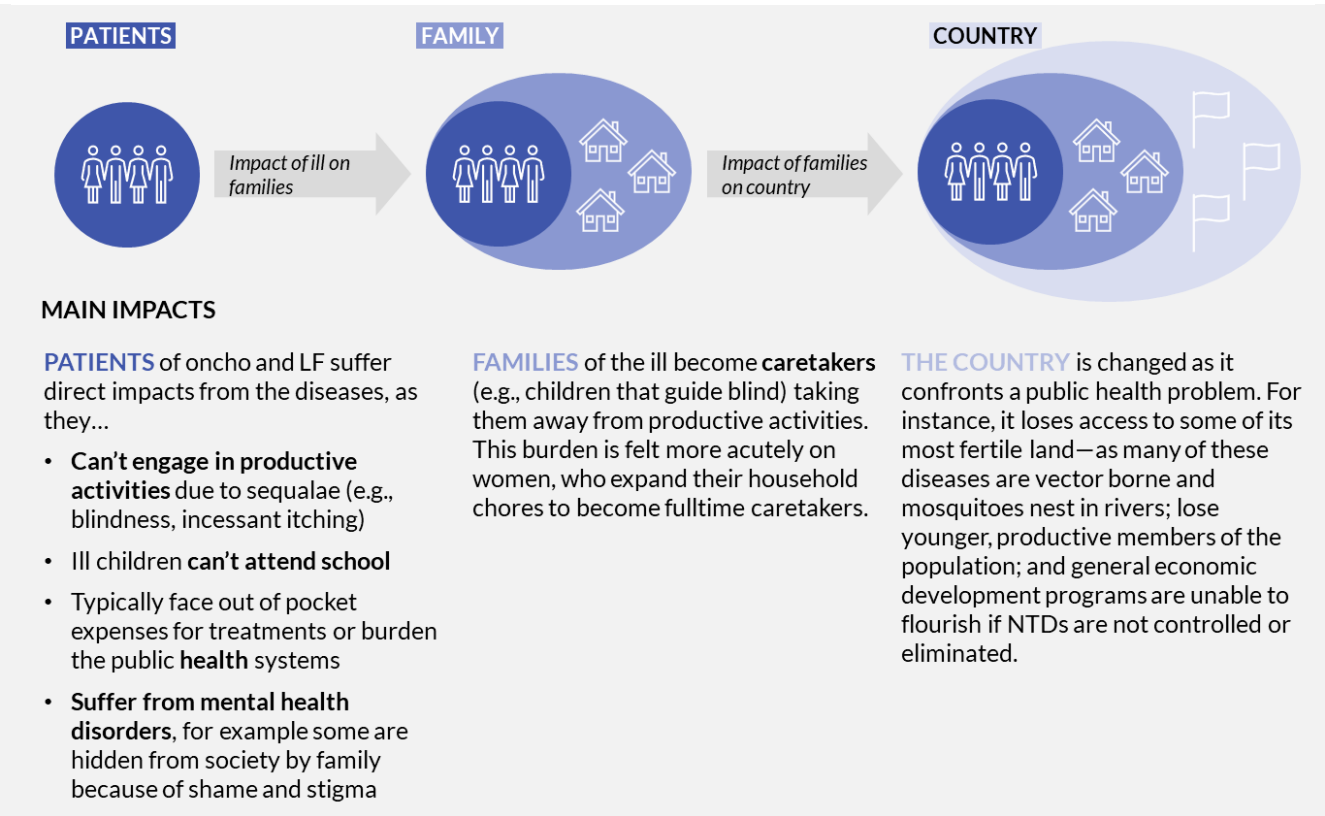
Understanding the
primary benefits of
oncho and LF
elimination

SECTION II

THE PRIMARY BENEFITS OF ONCHO AND LF ELIMINATION

Countries that eliminate oncho and LF bolster their socioeconomic conditions by creating important benefits at three levels (Figure 1).

Figure 1: Main impacts of an NTD in a country



1. **Patients.** The prevention and treatment of oncho and LF directly affects patients' livelihoods, improving health outcomes and decreasing morbidities (i.e., preserving eyesight, recovering healthy lymphatic drainage, and reducing skin conditions). For patients, this results in (i) increased productivity as they are able to rejoin the workforce at their full capacity; (ii) the alleviation of spending on health services to treat morbidities; (iii) greater average levels of education among treated children, which ultimately boosts their long-term earning potential; and (iv) improved mental health as they no longer face significant stigma.
2. **Families** of patients are acutely affected when a member is sick with oncho or LF, particularly when a family member suffers from symptoms that require constant care, such as blindness. When these high-burden symptoms are avoided or reversed, caretakers can rejoin the workforce.¹ This especially benefits women, who are disproportionately tasked with caretaking responsibilities, and creates an important multiplier effect on communities.²

¹ Our model accounts for patients that would have been ill that were not and for sequelae that could be reversed. For further details on the sequelae and how the counterfactual was estimated please refer to the Annex section in this report.

² CGI, "Empowering girls & women"

Specifically, women, on average, reinvest up to 90% of their earnings in their families through spending on health and education, while men reinvest just 35%. In addition, by avoiding stigma around NTDs, families also enjoy significant mental health benefits.

3. **Countries** enjoy significant gains from the elimination of oncho and LF. People can re-enter and begin farming the land where diseases were previously endemic, creating a more balanced distribution of the population. NTD elimination programs also strengthen institutional capacity by (i) training staff on disease control, (ii) developing water, sanitation, and hygiene (WASH) infrastructure, and (iii) creating and strengthening channels through which to implement programs (e.g., community-based networks).

Not all benefits engendered by oncho and LF elimination can be quantitatively estimated with a high degree of confidence. Elusive benefits (e.g., mental health improvements achieved only after the elimination of the diseases) and insufficient data quality (e.g., regarding migration trends inside focus countries) hamper efforts to accurately capture these effects. Hence, we have divided our analysis into two sections: (i) quantitative estimates that capture more direct benefits, such as productivity, education, and caretaker contributions; and (ii) qualitative analyses, which highlights benefits that are widely recognized but more difficult to estimate, such as improved mental health, increased women's employment, and improvements to infrastructure.

ESTIMATING ECONOMIC BENEFITS: THE NIGER CASE

Methodology

Using demographic, prevalence, and sequelae (symptom) data, this analysis estimates the more immediate benefits of oncho and LF elimination at a patient and family level. Figure 2 provides a simplified view of the main economic benefits. These represent only part of the impacts expected from elimination. Hence, they are considered a conservative estimate of the overall effects. For more details on the methodology and assumptions underlying it, please refer to the Annex.

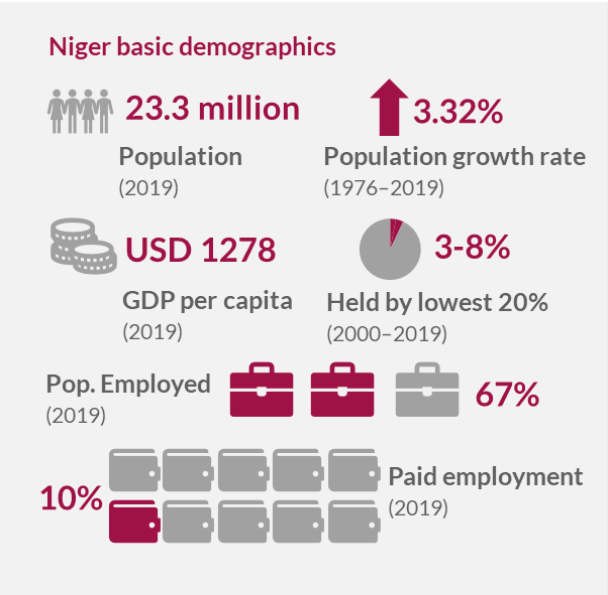
Figure 2: Economic benefits captured in assessment

TOTAL ECONOMIC BENEFITS	PRODUCTIVITY BENEFITS	HEALTH BENEFITS	CO - BENEFITS
	• Added productivity of people that join the workforce – who otherwise wouldn't have – due to NTD treatments. Composed of lives saved, new entrants of the workforce, and improved productivity for existing workforce • Additional productivity from extra schooling of children	• Saved resources by the government that arise from people who stop seeking aid in health centers due to NTD sequelae • Out-of-pocket spending of households is considered zero, as people usually suffering from NTDs do not seek paid care	• Added workforce of caretakers who couldn't work before as they spent most their time taking care of NTD ill • Economic impact of more women caretakers reinvesting in their community as households, as women investments have a proven multiplier effect in the economy

Country spotlight: Niger

Socioeconomic overview of Niger

Located in the heart of the Sahel, Niger is highly dependent on agriculture and is classified as an extremely low-income country by the World Bank. Its economy is highly undiversified. Approximately 40% of its gross domestic product (GDP) and 80% of its population’s income depend on agriculture. However, agriculture is difficult because 75% of the country’s land lies in the Sahara Desert. Over 10 million Nigeriens live in poverty. This is equivalent to 43% of the country’s population (2020).¹ Most poor Nigeriens lived through or have family members who lived through periods of local oncho and LF endemicity.

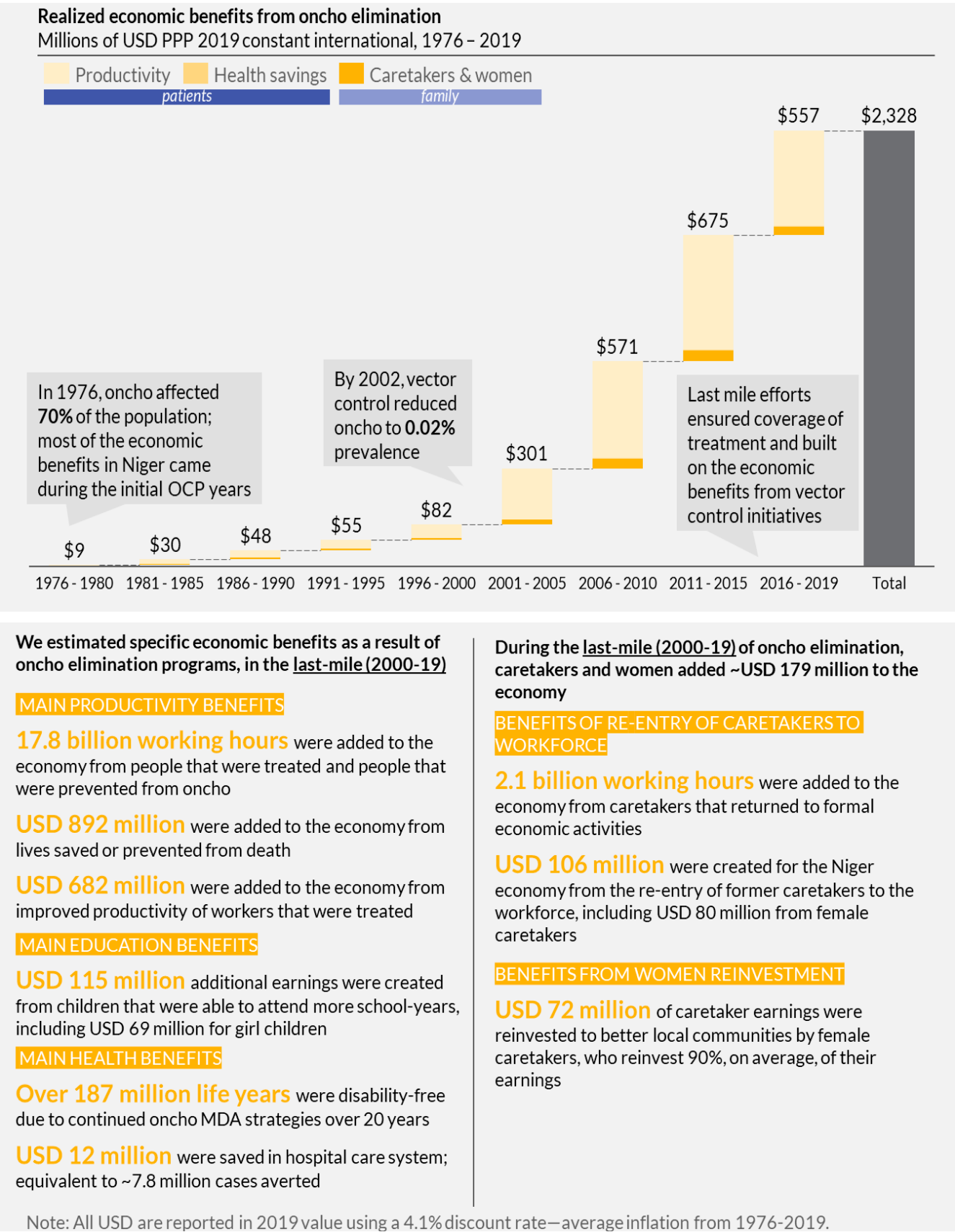


Oncho elimination in Niger

Niger used vector control between 1974 and 2002 to nearly eliminate oncho. The Onchocerciasis Control Programme (OCP) implemented a rotation of five insecticides to eliminate larvae in the rivers of Southwest Niger. By 2002, the prevalence of oncho had declined to almost zero with only a few remaining cases in last-mile areas. Surveillance from 2002 to 2015 continued to show low disease prevalence. The World Health Organization (WHO) plans to certify oncho elimination in 2021, and experts credit mass drug administration (MDA), including ivermectin distribution, for being the final mechanism that made this possible.

By eliminating oncho, Niger created USD 2.3 billion in economic benefits. The country added over 17.8 billion working hours and approximately USD 682 million to GDP through the improved productivity of treated workers. Furthermore, families with NTD infected members were also able to rejoin the workforce, adding an estimated USD 179 million to GDP. Of particular note, newly employed women invested an estimated USD 72 million (90%) of their earnings in the health and education of their children or the betterment of their community. Figure 3 provides estimates of these quantified economic benefits over time.

Figure 3: Economic benefits from oncho elimination in Niger

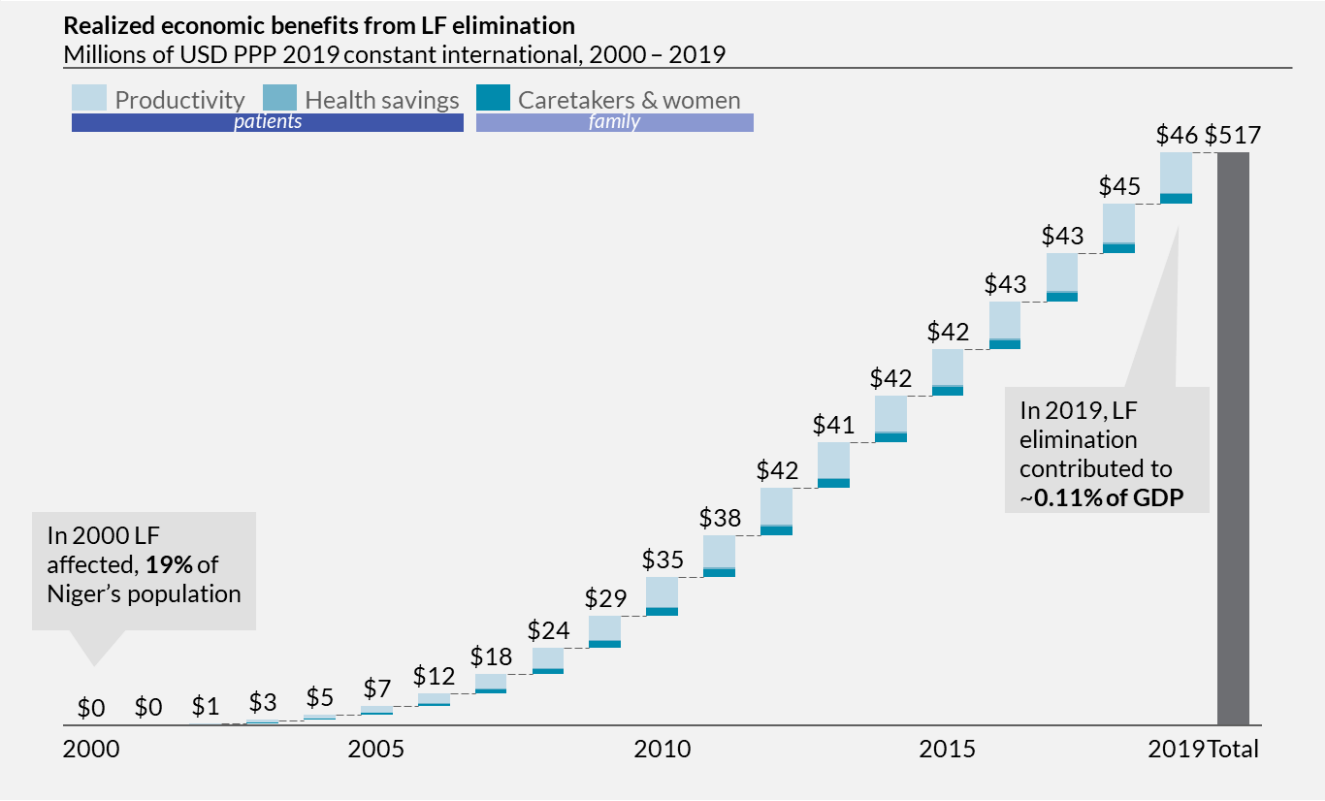


LF control in Niger

LF is considered to be controlled in Niger. Over the past 20 years, Niger has reduced LF prevalence in all 54 health districts, with 32 discontinuing treatment after having achieved the WHO criteria of elimination. Drug treatment of at-risk populations continues in the remaining 22 health districts. Though the Global Programme to Eliminate Lymphatic Filariasis (GPELF) does not include vector control, experts believe the vector control efforts of other disease programs, such as those for malaria and oncho, have benefited LF mitigation.

Niger created USD 517 million in economic benefits as a result of controlling LF. The country has added over 3.2 billion working hours and USD 294 million to GDP through the improved productivity of treated workers. Furthermore, families with NTD infected members were also able to rejoin the workforce, adding an estimated USD 97 million to GDP. Newly employed women invested an estimated USD 39 million (90%) of their earnings in the health and education of their children or the betterment of their communities. Figure 4 provides estimates of these quantified economic benefits over time.

Figure 4: Economic benefits from LF elimination efforts in Niger



We estimated specific economic benefits from the treatment of LF in Niger patients over the last 20 years

MAIN PRODUCTIVITY BENEFITS

3.2 billion working hours were added to the economy from people that were treated and people that were prevented from LF

Employees who avoid LF or are treated for LF **earn 4-times** the average GDP per capita over their lifetime

~USD 294 million were added to the economy from improved productivity of workers that were treated

MAIN EDUCATION BENEFITS

USD 4 million additional earnings were created from children that were able to attend more school-years, including USD 2.4 million for girl children

MAIN HEALTH BENEFITS

Over 32.3 million life years were disability-free due to LF MDA strategies over 20 years

USD 20 million were saved in hospital care system; equivalent to ~2.9 million cases averted

LF control has also created significant benefits for the families of treated patients and ~USD 97 million for the economy

BENEFITS OF RE-ENTRY OF CARETAKERS TO WORKFORCE

USD 57 million were created for the Niger economy from the re-entry of former caretakers to the workforce, including USD 43 million from female caretakers

BENEFITS FROM WOMEN REINVESTMENT

USD 39 million of caretaker earnings were reinvested to better local communities by female caretakers, who reinvest 90%, on average, of their earnings

Note: All USD are reported in 2019 value using a 4.1% discount rate—average inflation from 1976-2019.

ADDITIONAL BENEFITS: GOING BEYOND MEASURABLE IMPACT

Oncho and LF elimination creates long-term, hard to measure benefits for people and countries. Numerous efforts to quantify these impacts have been initiated around the world. Replicating these studies in RLMF countries proved difficult, given current travel limitations because of COVID-19 and the objective of this work. However, studies from other regions were leveraged to illustrate how such benefits manifest.

Mental health benefits

Oncho and LF burden patients and their families with significant challenges to mental health. For instance, a study in India estimated that LF patients are 97% more likely to suffer depression or feelings of inferiority.³ Social stigma, shame, and discrimination drive such feelings. Moreover, physical impairments caused by these diseases such as incessant itching, lymphedema, hydrocele, and blindness correlate with greater stress and decreased productivity.⁴

Poor mental health exacerbates the adverse effects of oncho and LF on a person's livelihood. It leads to the exclusion of patients (and sometimes their family members) from educational opportunities, employment, and marriage.⁵ By avoiding these diseases or reversing their

³ Ibid
⁴ Ton et al., "The burden of mental health in lymphatic filariasis," 2015
⁵ Litt et al., "Neglected tropical diseases and mental health: a perspective on comorbidity," 2012

symptoms, patients can re-enter society, freed from physical constraints and able to engage in household and community activities.

“The burden of mental health from oncho is huge. Many people believe you get these diseases because you’ve done something wrong. For instance, people who get it are believed to have slept with the neighbor’s wife. If the community finds out you have oncho you will be shunned, so people hide it and live with this burden and shame in solitude.”

– NGO worker in Niger

Gender benefits

Disease prevalence disproportionately affects women, who, in addition to their already demanding share of household responsibilities, are often expected to act as primary caretakers for patients. Reducing the burden of care by eliminating oncho and LF can liberate women to pursue activities that empower them with income. In Niger, newly employed women who were formerly caretakers earned an estimated USD 123 million and reinvested 90% of this income (USD 111 million) in their families and the betterment of their communities.

Oncho and LF patients who are female face constraints on social interaction that men are less likely to experience. As stated earlier, the symptoms of oncho and LF can place undue pressure on the mental health of patients. Women bear a disproportionate burden, as oncho-related skin disease can affect social interactions. In Nigeria’s Imo State, 78% of affected women said onchodermatitis reduced their social interaction and that marriage prospects are severely limited or unavailable for women with severe onchodermatitis. While both men and women face stigma for hydrocele symptoms from LF, abandonment and divorce were higher amongst female patients.⁶ Young girls who are treated for oncho and LF are likely to achieve comparably higher levels of education and may, as a result, earn more in their lifetime. For example, in Niger, the population of girls who were treated earned an estimated USD 71 million more over a 45-year period due to additional years of schooling.

Access to fertile land

Disease vectors nest in rivers, making river basins—some of the most fertile lands—uninhabitable. When oncho was endemic across West Africa, communities that lived near rivers exhibited higher incidence. As a result, millions of people abandoned these areas, often forgoing agriculture on family land, while the infected people who stayed behind suffered severe symptoms such as blindness or incessant itching, which greatly limited their productivity.

Once vectors were eliminated, people returned to river basins and resumed their economic livelihoods. OCP vector control interventions resulted in the re-population of ~25 million hectares of abandoned land, estimated to produce enough food to feed 17 million people

⁶ Nwoke et al., “[Pattern and perception of onchocerciasis among women in oncho-endemic areas of Imo State of Nigeria](#),” 2005

annually.⁷ By facilitating access to fertile land, particularly in the Sahel where arable land is scarce, vector control revitalized agricultural production in the OCP countries.⁸

Systems strengthening

The establishment of a data-driven culture in local governments helped optimize resources and set countries up for WHO elimination certification. Niger continued to use the data infrastructure built as part of the OCP and the African Programme for Onchocerciasis Control (APOC) even after the initiatives ended. These programs trained local staff to capture and use key data for decision-making. This has been critical to ongoing government efforts to monitor oncho prevalence and identify potential outbreaks.

Early elimination efforts created local institutions that could sustain efforts after international support ended. While elimination efforts were underway, the Ministry of Public Health (MoPH) of Niger created a centralized NTD structure to continue activities of NTD programming after donor support ended. This centralized structure has now taken the lead on additional critical NTD activities, such as convening health experts, tribal leaders, community organizations, and other key actors to formulate integrated strategies (e.g., WASH) in the fight against NTDs.

⁷ WHO, Onchocerciasis Fact Sheet, 2019
⁸ Benin, Burkina Faso, Côte d'Ivoire, Ghana, Guinea Bissau, Guinea, Mali, Niger, Senegal, Sierra Leone, and Togo

The journey from public health problem to elimination

SECTION III

MOVING ONCHO AND LF FROM ENDEMIC TO CONTROLLED

Neglected Tropical Diseases affect one in five people across the world.⁹ People affected by NTDs commonly live in areas where access to quality health services, clean water, and sanitation is scarce. NTDs reinforce and perpetuate poverty by hampering the ability of patients and their families to study, work, and lead healthy and productive lives. Moreover, the cultural and economic landscapes of countries were changed as communities had to abandon their villages as these diseases made them uninhabitable.¹⁰

The elimination of two NTDs, oncho and LF, is within reach.¹¹ Oncho, also known as River Blindness, is caused by a parasitic worm transmitted through blackflies. It can result in severe skin disease (onchodermatitis) or permanent blindness.¹² LF is caused by different parasitic worms transmitted through mosquito bites; it can impair the lymphatic system and lead to elephantiasis (abnormal swelling) in parts of the body.¹³ In the 1970s, both diseases posed significant public health problems across Africa, Latin America, and Asia. However, various stakeholders, including donors, multilaterals, local governments, private sector actors, and NGOs, came together to successfully reduce their incidence.

In 1974, the Onchocerciasis Control Programme (OCP) was launched to control oncho in Benin, Burkina Faso, Côte d'Ivoire, Ghana, Guinea Bissau, Guinea, Mali, Niger, Senegal, Sierra Leone, and Togo. This program focused primarily on vector control and, after 1988, massive drug administration (MDA) of ivermectin. It was led by the World Bank, WHO, the United Nations Development Programme (UNDP), the Food and Agriculture Organization (FAO), and bilateral donors. OCP concluded in 2002, costing a total of USD 750 million and achieving key results, including the treatment of 40 million people, the preservation of sight for 600,000 people, and the return of 25 million hectares of abandoned land to a habitable state.¹⁴

In 1995, the Non-Governmental Development Organizations group (NGDO) along with sponsoring agencies extended OCP's efforts by launching the African Programme for Onchocerciasis Control (APOC). APOC covered a bigger area than OCP—19 countries—and prioritized the more active involvement of ministries of health and affected communities. The

⁹ Reaching the Last Mile, [Mid-Year Report](#), 2020

¹⁰ Given prevalence has gone down in recent years, village abandonment is no longer common. Turner et al., "[The health and economic benefits of the global programme to eliminate lymphatic filariasis \(2000–2014\)](#)," 2016

¹¹ As defined by the WHO control is a reduction in the incidence, prevalence, morbidity or mortality of an infectious disease to a locally acceptable level; elimination is the reduction to zero of the incidence of disease or infection in a defined geographical area; and eradication is the permanent reduction to zero of the worldwide incidence of an infection

¹² The scientific name of the worm that causes oncho is *Onchocerca volvulus*

¹³ The three types of filarial worms that can cause LF are *Wuchereria bancrofti* (responsible for 90% of cases), *Brugia malayi* (causes most of the remainder of cases), and *Brugia timori*

¹⁴ Bundy et al., "[Investing in Onchocerciasis Control: Financial Management of the African Programme for Onchocerciasis Control](#)," 2015

program concluded in 2015, after successfully treating over 90 million people, protecting an at-risk population of 115 million, and preventing over 40,000 cases of blindness annually.¹⁵

Today, oncho is considered under control or eliminated in the RLMF focus countries.¹⁶ Through OCP, oncho is suspected to have been eliminated in Niger. The country is currently certifying elimination in line with WHO criteria.¹⁷ In addition, oncho is no longer a public health problem in four of the other six countries addressed by the RLMF.¹⁸ This achievement is considered a pre-elimination phase. In 2019, oncho prevalence was above 1 percent only in Chad (1.4%) and Yemen (10%) and was below 1 percent in Mali, Senegal, Sudan, and Ethiopia.^{19,20}

For LF, the global fight started in 2000, with the Global Programme to Eliminate Lymphatic Filariasis (GPELF) led by WHO. This ongoing program focuses on MDA of albendazole and ivermectin.²¹ Vector control is not considered a cost-effective strategy to eliminate LF given the wide variety of mosquitos that transmit it.²² At a global level, GPELF has delivered over 7.7 billion treatments to more than 910 million people. It has positively impacted RLMF countries, with LF declared eliminated in Yemen in 2019 and considered under control in the other six RLMF countries.²³

Today, governments must lead efforts to eliminate oncho, LF, and other NTDs. Many national governments have created centralized NTD structures to lead and coordinate interventions in partnership with donors. For example, all RLMF focus countries have government-led NTD programs within their Ministries of Health. These platforms (i) help coordinate more systemic approaches to NTD elimination (e.g., WASH investments), (ii) monitor and evaluate progress towards elimination, and (iii) coordinate efforts across NTDs (e.g., the tandem distribution of MDAs for LF and oncho).

However, it will be difficult for governments to eliminate these diseases without the support and resources of the international community. Additional support from a range of expert stakeholders remains critical. Elimination of transmission is highly technical and scientific in nature, and very few experts have the depth of understanding of transmission dynamics required to achieve an interruption of transmissions. Governments would also benefit from support for

greater data collection and usage capacity. In addition, stakeholders can support access to and management of donations from private companies (e.g., ivermectin donations).²⁴

With such goals in mind, the RLMF is helping its focus countries with the required technical expertise, and to optimize their resources and efforts to achieve the elimination of transmission of oncho and LF.

¹⁵ WHO, “African Programme for Onchocerciasis Control,” consulted in 2020

¹⁶ Senegal, Mali, Niger, Chad, Sudan, Ethiopia, and Yemen

¹⁷ WHO definition of Elimination of disease/infections: Reduction to zero of the incidences (new cases) of a specified disease or infection caused by a specific agent in a defined geographical area as a result of deliberate efforts; continued intervention measures are required to prevent re-establishment of transmission are required

¹⁸ Oncho continues to be a public health problem in Ethiopia and Sudan, where blinding oncho still exists. Mapping is still ongoing in Ethiopia. There remain mapping goals in Yemen, which cannot be carried out due to the civil war.

¹⁹ IHME GHDx Database, onchocerciasis prevalence rates, 2019

²⁰ Civil unrest in Yemen has slowed MDA efforts significantly, but the country has achieved control of the disease nationally. WHO, “[Despite civil unrest, almost half a million Yemenis treated for onchocerciasis](#),” 2019

²¹ The normal treatment for LF is with albendazole and ivermectin. Diethylcarbamazine is added to this therapy in limited circumstances where oncho is not present. All RLMF countries are treated with only albendazole and ivermectin.

²² H. Turner et al., “[Investment Success in Public Health: An Analysis of the Cost-Effectiveness and Cost-Benefit of the Global Programme to Eliminate Lymphatic Filariasis](#)”, 2017

²³ IHME GHDx Database, lymphatic filariasis prevalence rates, 1990–2019

²⁴ Merck & Co.’s production of ivermectin is registered as Mectizan®

HOW ELIMINATION IS ACHIEVED

Countries with the support of stakeholder coalitions have successfully eliminated oncho and LF in different countries using two main strategies:

- 1. Mass drug administration, which is cost-effective against both diseases, and;
- 2. Vector control which is only cost effective against oncho in specific country contexts.²⁵

Mass drug administration

MDA is the main oncho and LF elimination strategy used today. Ivermectin is a drug used to treat oncho and is combined with albendazole—and diethylcarbamazine in some cases where oncho is not present—to treat LF.²⁶ Merck & Co. supplies ivermectin through a donation program created in 1987, which has donated over 7.8 billion tablets.²⁷ MDAs are cost-effective in design and can reach areas where vector control is impractical or not cost effective. The internal rate of return of MDA in oncho is estimated to be between 11 and 24 percent.²⁸

MDA with ivermectin has two key limitations: (i) it requires a long-term commitment, and (ii) it has limited applicability in places co-endemic with *Loa loa*. Preventative and targeted treatment with ivermectin requires MDA to occur annually for 10–15 years. Sustaining long-term efforts can be difficult to achieve in countries with heightened political instability or highly nomadic populations.²⁹ Ivermectin can also cause severe side effects in countries that are co-endemic with *Loa loa*, a filarial parasite endemic in Central and West Africa.³⁰ Therefore, in countries with co-endemicity with *Loa loa*, alternate solutions must be used.³¹

²⁵ Based on the analysis done by the WHO that concluded that *Larviciding is usually not effective or sustainable for filariasis vector control (except in special situations), so this method is generally discouraged as uneconomic and inappropriate for the GPELF. Participants were unable to identify reliable methods for cost-effective control of Aedes or Mansonia vectors of LF, other than general source reduction and environmental management in conducive situations.* WHO, “[Defining The Roles of Vector Control and Xenomonitoring in the Global Programme to Eliminate Lymphatic Filariasis](#)” 2002

²⁶ Williams et al., “[The role of medicine donations in the global programme for the elimination of lymphatic filariasis,](#)” 2020

²⁷ WHO, [Medicine donation program](#), 2017

²⁸ Turner et al., “[Economic evaluations of onchocerciasis interventions: a systematic review and research needs,](#)” 2019

²⁹ Ivermectin is an microfilaride that kills the larvae but cannot kill adult worms. Preventative and targeted treatment with ivermectin requires MDA to occur annually for 10–15 years to kill all new larvae and prevent recurrence. Magori, K., “[NTDs, violent conflicts, and the role of military in global health,](#)” 2018

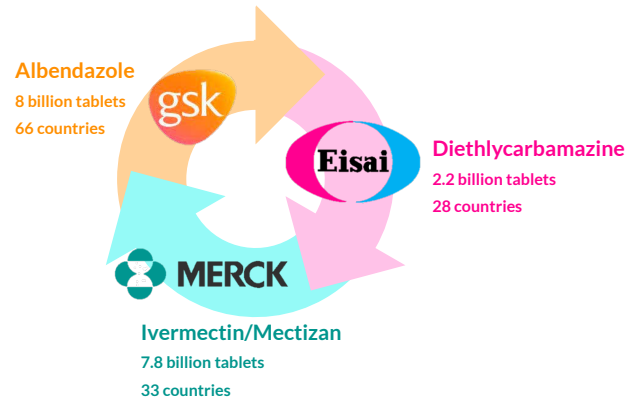
³⁰ Individuals with high levels of *Loa loa* microfilariae who take ivermectin or other microfilaricides are at heightened risk of encephalopathy, for which there is no cure. Twum-Danso, N., “[Loa loa encephalopathy temporally related to ivermectin administration reported from onchocerciasis mass treatment programs from 1989 to 2001: implications for the future,](#)” 2003

³¹ Alternate solutions include Loascope, twice annual treatment with albendazole alone, or preliminary testing for oncho

Private actors’ unwavering support

GPELF engaged a global partnership of public and private actors, including three pharmaceutical companies to gather donations of critical medicines (Figure 5).

Figure 5: GPELF medicine donation partners



Merck & Co.: Mectizan®. The Mectizan® Donation Program (MDP) was established in 1988 as a public private partnership between Merck & Co., the WHO, and endemic countries. It is the longest running drug donation program. MDP reaches more than 300 million people annually and has donated over 4 billion treatments over 30 years. Merck & Co. had donated Mectizan® (also known as ivermectin) in 33 countries as of 2018.

GlaxoSmithKline (GSK): Albendazole. Albendazole is co-distributed with Mectizan® to treat LF patients in countries that are co-endemic with oncho. Since 2000, GSK has donated 8 billion albendazole tablets across 66 countries. GSK has pledged to provide albendazole to every country in need until LF is eliminated as a public health problem.

Eisai: Diethylcarbamazine citrate (DEC). DEC is not administered in any RLMF countries. This drug is only co-administered with ivermectin and albendazole in countries where oncho is not present for “triple therapy” to accelerate LF elimination. In 2010, Eisai pledged to provide 2.2 billion DEC tablets to the WHO by 2020 and in 2017 announced a continuation of its donation program until elimination is reached in all endemic countries. Since 2013, Eisai has donated to 28 countries.

Vector control

Vector control was a key tool used by the OCP to combat oncho. Blackfly breeding sites were continuously sprayed using a rotation of larvicides—larvae can develop resistance to the chemical if only one larvicide is overused. This strategy has proven effective. Niger achieved elimination of oncho as a public health problem using only vector control.

However, vector control interventions can be expensive and difficult to manage and may not be appropriate for all country contexts. This strategy can require expensive equipment (e.g.,

helicopters and planes), quality data (e.g., to identify where to spray and which larvicides to use), extensive regional coordination (e.g., countries must allow free movement and protection of planes spraying larvicides), and specialized human capital (e.g., data analysts and pilots). To achieve vector control, OCP conducted weekly aerial spraying over 14 years, finally breaking the life cycle of the black fly in some regions.³²

Complementary initiatives

The OCP and APOC programs created surveillance infrastructure that fostered a data-driven culture in local governments. The programs optimized resources across participating countries and provided tools to maximize the impact and efficiency of interventions. Local staff learned sample testing methodologies, data collection, and surveying techniques to capture the data needed to monitor progress in endemic areas. The programs developed an epidemiological mapping tool and treatment guides to support participating countries and build their management and monitoring capacity. These resources informed the decision-making process of health officials and identified areas at risk of recrudescence. Niger utilized and sustained data infrastructure built during the OCP and APOC years to support more recent surveillance efforts and meet WHO oncho-elimination requirements.

Incorporating water and sanitation (WASH) strategies can help improve the management of morbidities. MDA campaigns require access to safe drinking water to administer drugs. Patients with elephantiasis require clean water to wash affected limbs. For instance, in Niger 58% of the population have improved access to water facilities, while only 10% have access to improved sanitation. Thus, the country opted to pro-actively coordinate NTD interventions with WASH actors during MDA campaigns. In 2019, USAID and public health authorities brought together key stakeholders across the WASH and NTD sectors to not only coordinate interventions but also develop a common communication plan. This resulted in a more holistic approach to NTD elimination.³³

Education campaigns that focus on changing attitudes and promote preventive behaviors have proven essential to a holistic strategy. Patients disabled by LF or oncho face social stigmas associated with the disease and often avoid treatment. In Niger, proactive door-to-door campaigns coupled with financial incentives of up to ~USD 120 to help change attitudes and encourage people to come forward for treatment. Many people now associate taking ivermectin with stronger health and improved quality of life.³⁴ During MDAs, trained community drug distributors (CDDs) engage directly with local populations to inform them about treatment options.

Elimination strategies that focused on transmission reduction as well as morbidity management were critical in reaching last-mile communities. One of GPELF's core strategies focuses on morbidity management and disability prevention (MMDP), a crucial component of

elimination. Despite drastic reductions in new cases, the presence of these diseases is still felt within communities through patients with visible symptoms. In Senegal, cases of hydrocele were identified in LF patients during the start of the first MDAs in 2007 but were not treated due to a lack of financial resources to conduct surgeries. It was only after MDAs were scaled up in 2014 and prevalence rates started diminishing that the focus turned towards disability management.³⁵ Dedicating additional resources to support MMDP initiatives that address treatable symptoms of oncho and LF are an integral part of last-mile efforts.

WHY MOVING FROM CONTROL TO ELIMINATION IS IMPORTANT

The battle against oncho and LF yields the greatest benefits when countries move from endemicity to controlled prevalence. In the 1970s, in the Sahel region, oncho prevalence was as high as 70% in some countries. This significantly hindered national productivity, increased government and household spending on health, and rendered some of the most fertile land unproductive because river basins were abandoned. As soon as countries began reducing incidence, benefits became apparent. The economic costs and barriers to growth subsided, and opportunities for patients, families, and countries emerged.

However, failing to eliminate oncho and LF in the last mile exposes countries to costly risks.

Control efforts that do not end with elimination pose a grave danger of recrudescence. This not only affects the countries that fail to eliminate oncho and LF but also their neighboring countries. The blackfly has an estimated flight range of over 300 km and nests along rivers.³⁶ These rivers frequently act as country borders, and hence, the risk of cross-border infestation is significant. If the NTDs reemerge, countries could lose the economic benefits they worked so hard to achieve, and past investments in NTD elimination efforts could be wasted.

Failing to support last-mile elimination can exacerbate existing inequality and drive more communities into poverty. These diseases have outsized impact on the most vulnerable individuals. People impacted by oncho and LF are normally at the base of the pyramid, living below poverty lines. Leaving these diseases unattended will continue to hinder this population's opportunities and leave them behind socioeconomically.

Finally, if countries fail to prioritize elimination, they will face the long-term costs of disease management. After control is achieved, the number of remaining morbidity cases is marginal. However, the last mile of the population that is still directly impacted by the diseases can generate additional costs (e.g., health-related costs) to the country. Furthermore, those affected will not be able to lead fully productive lives. Countries that do not quickly and effectively reach complete elimination are likely to require long-term NTD programming at significant costs. For example, Niger spent USD 2.7 million in 2012 alone to continue elimination efforts; these costs could have been avoided if complete elimination was achieved before then.³⁷

³² WHO, [Onchocerciasis control](#)

³³ USAID, Act to End Neglected Tropical Diseases | West Program, FY2020 Annual Work Plan, 2020

³⁴ Dalberg interviews, NGO, 2021

³⁵ Senegal [NTD Master Plan 2016-2020](#)

³⁶ Liese et al., [The Onchocerciasis Control Program in West Africa](#), 1991

³⁷ Niger Ministry of Public Health, [National Master Plan for NTDs](#), 2016–2020

A call to action: how we can reach elimination everywhere

SECTION IV

ELIMINATION IS IN SIGHT

We can eliminate oncho and LF in every corner of the world. The tools to eliminate these diseases have existed for more than 50 years and there is strong evidence that they are safe, accessible, and effective. Until oncho and LF are eliminated, there will be a risk that benefits accrued through years of control efforts could be wiped out. If countries must restart the process of elimination, the economic toll will be great.

Creative solutions are required to address the remaining challenges to last-mile elimination. Political instability, cross-border migration, interspecies transmission, and antimicrobial resistance increase the complexity of last-mile elimination. Identifying, reaching, and monitoring the places where these diseases persist will require significant resources. But programs such as APOC and initiatives to integrate NTD treatment with other disease management strategies illustrate how creative approaches can bolster these efforts.

The benefits of elimination are significant, particularly for the most marginalized communities. As illustrated in the previous sections, by eliminating these diseases, countries help their most marginalized citizens achieve improved livelihoods while also improving the economic outlook of the nation.

Niger and other countries that have eliminated NTDs can provide valuable lessons to those still working towards elimination.

- **An international approach is critical in the fight against NTDs.** Vectors commonly cross between national borders (e.g., near rivers). Additionally, people immigrating between countries can carry NTDs. Successful programs, such as OCP, have been international in scope. They allow for effective control of vectors across multiple countries and mitigate the risk of recrudescence. In new and ongoing efforts, neighboring countries will need to cooperate and support one another in their paths to NTD elimination.
- **Embedding elimination efforts with a data-driven culture is critical to optimizing resources and fostering a data culture in countries.** Niger continued to use the data infrastructure built during the OCP and APOC programs, after these efforts ended, to monitor oncho prevalence and identify areas at risk of new outbreaks. These programs trained local staff on best practices to capture and utilize data. Reaching the last mile will require a community-centered approach that prioritizes data analysis to inform critical decisions.
- **Educating people about NTDs changes their attitudes towards the diseases and enables them to participate in achieving elimination.** Niger's community strategy to battle NTDs used proactive door-to-door campaigns coupled with financial incentives. NGOs report that people are now much more amenable to taking ivermectin. Many relate it to better health and an improved quality of life. Such community support is critical to the successful implementation of health programs.
- **By creating local institutions that can continue control and monitoring efforts countries can sustain positive results even after international support ends.** The Ministry of Public Health of Niger created a centralized NTD structure to continue NTD programming after

donor support ended. It now leads on many critical NTD activities, such as convening health experts, tribal leaders, community organizations, and other key actors to formulate integrated strategies (e.g., WASH) in the fight against NTDs. These collaborative platforms and integrated approaches ensure that Niger’s progress will endure.

A CALL TO ACTION

The RLMF calls on governments, donors, private sector actors, and NGOs to maintain and scale support to achieve elimination of oncho and LF in Chad, Mali, Niger, Senegal, Sudan, Ethiopia, and Yemen.³⁸ Specifically, the RLMF asks that:

Governments

- Continue leading activities laid out in the WHO 2030 road map for NTDs
- Invest money, in addition to time and resources, to indicate commitment towards elimination and partnership with donors
- Coordinate and educate donors to improve awareness of the costs and contributions being made by governments, highlighting sustainability initiatives, such as sustainability assessments, that increase local ownership of NTD programming
- Collaborate with neighboring countries to address vector control and MDA along borders where necessary
- Integrate cross-cutting health efforts with NTD efforts in last-mile interventions, for example, by coupling MDA for NTDs with other key initiatives (e.g., COVID-19 information and vaccines)

Donors and multilaterals

- Provide resources earmarked for the last-mile elimination of oncho and LF
- Train local stakeholders to manage efforts to eliminate oncho and LF
- Advocate for NTD elimination to other key stakeholders

Private sector actors

- Continue to donate drugs to help eliminate oncho and LF in last-mile contexts
- For pharmaceutical or health service actors, continue to research and innovate to find new and more effective ways to eliminate diseases (e.g., by developing a safe macrofilaricide to kill adult worms)
- Provide financial resources to accelerate the progress of last-mile elimination programs. Investments made in last-mile elimination are investments in a healthier workforce, a stronger brand, and more engaged customers

NGOs

- Support the National NTD programs to deliver health services to last-mile communities, including providing training and support for data-collection in a way that promotes country leadership and ownership of the data and its use
- Support the development of country-level surveillance systems to monitor for signs of recrudescence of disease after treatment stops ensuring that the system follows best practices and will be affordable to countries after donor funding ends
- Continue advocating on behalf of communities to raise awareness among national and global governing bodies

³⁸ Elimination is defined as interruption of transmission

Annex

SECTION V

ADDITIONAL COUNTRY CASE STUDIES

Senegal

Senegal's approach to NTDs included national ownership of surveillance and coordination activities, including the development of a national health data system. Senegal is endemic for both oncho and LF. Senegal focused on national ownership of NTD programming, including capacity building across the health system, surveillance and research, and resource mobilization strategies. There was particular emphasis on capacity building of NTD actors with M&E capabilities and the development of a health IT data management system. The approach faced challenges as financing was donor-driven, which limited financial flexibility, and limited coordination amongst local stakeholders with donors.

Senegal's strategy for NTD management has focused on transmission reduction over morbidity management. Financial limitations caused the country to prioritize reducing transmission instead of early treatment of morbidities. This decision was critical in accelerating progress towards elimination, creating a sustainable reduction in cases.³⁹

Senegal is nearing elimination of oncho using a combination of early vector control and MDA. Three large river basins in Senegal are the primary sites of blackflies – the Faleme, Koalakabe, and Gambia. Vector control efforts in these river basins began in 1974 under OCP and while control was achievable, elimination was not an achievable goal with vector control alone. Senegal began using MDA with ivermectin in 1988; and the country serves as a use case proving that oncho elimination is achievable through MDA. This key finding underpinned the design of APOC. Senegal is nearing the WHO's criteria for elimination and is currently prioritizing disease management and last-mile efforts.⁴⁰ As of 2017, 8 health districts continue MDA as they are co-endemic for LF.

Senegal's LF elimination efforts are led by the GPELF strategy of MDA with ivermectin. Based on initial mapping exercises in 2003, 50 health districts in 12 of Senegal's 14 regions were endemic for LF. Ivermectin distribution began in 2007, and all endemic regions received at least one initial dose of ivermectin by 2015.⁴¹ In Senegal, cases of identified hydrocele were not originally treated due to limited financial resources. As prevalence decreases, there is a growing focus on treating morbidity-related disability from the disease.

Senegal has created an estimated USD 1.3 billion in economic benefits due to oncho and LF elimination efforts. The country added over ~52 million working hours and USD 421 million to GDP from improved productivity of workers that were treated between 1976 and 2019. Families of NTD infected people were able to rejoin the workforce adding an estimated USD 913,000 to GDP and investing USD 616 million back into their communities.

³⁹ [Senegal NTD Master Plan](#), 2020

⁴⁰ USAID, [Act to End NTD West Report FY2019](#), 2019

⁴¹ Wilson et al., ["Evaluation of Lymphatic Filariasis and Onchocerciasis in Three Senegalese Districts Treated for Onchocerciasis with ivermectin."](#) 2016

Figure 6: Economic benefits from oncho elimination efforts in Senegal

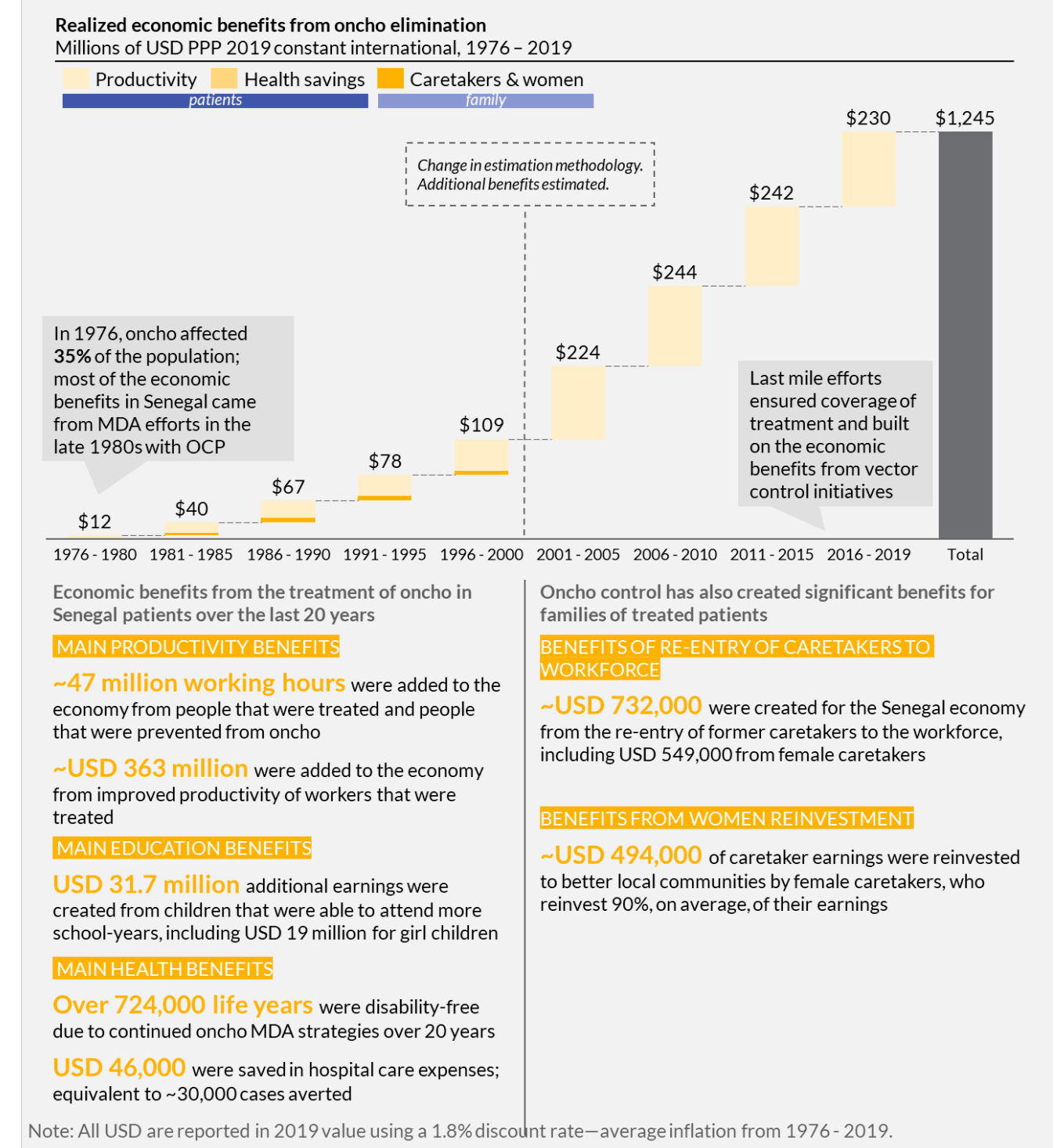
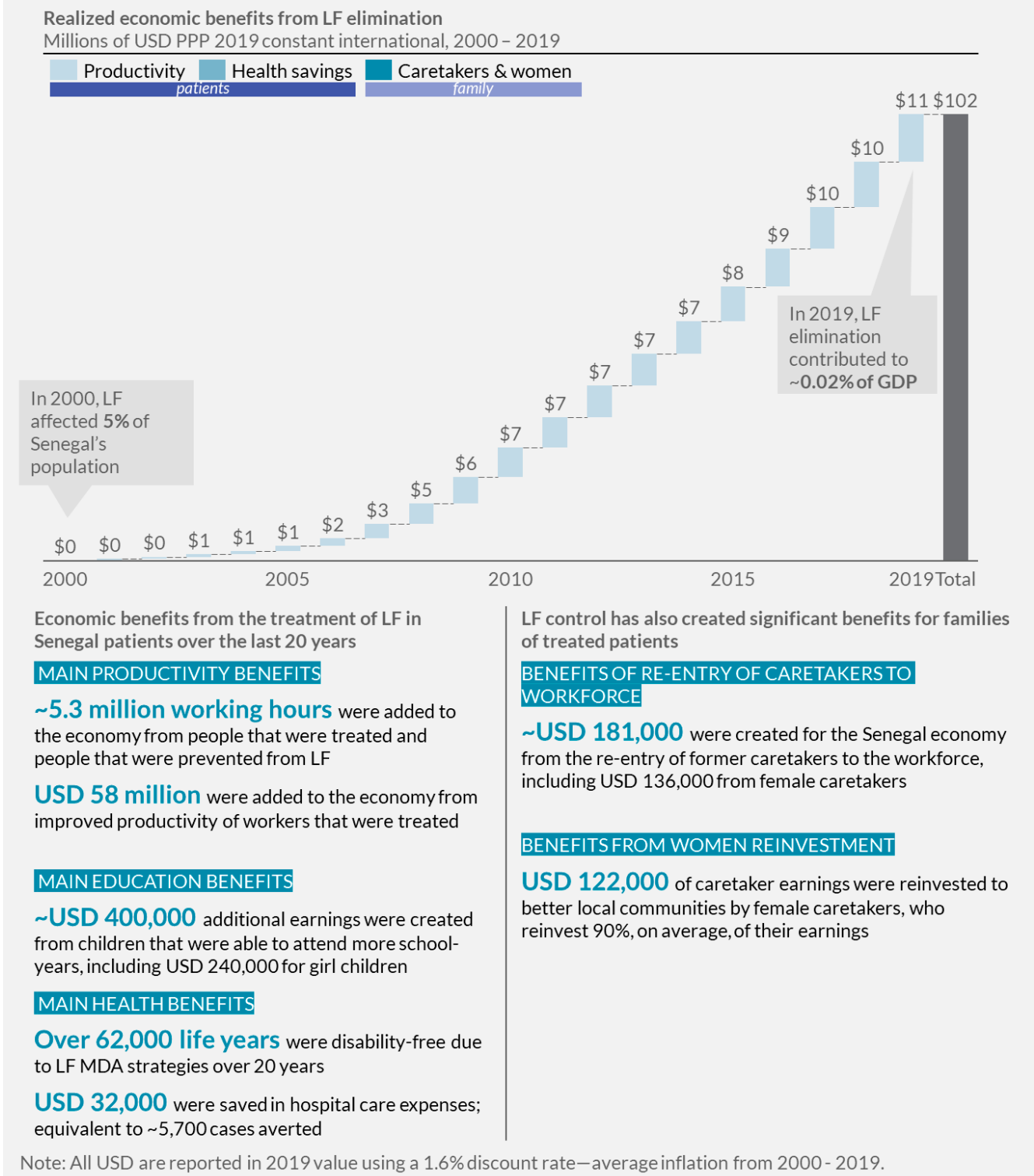


Figure 7: Economic benefits from LF elimination efforts in Senegal



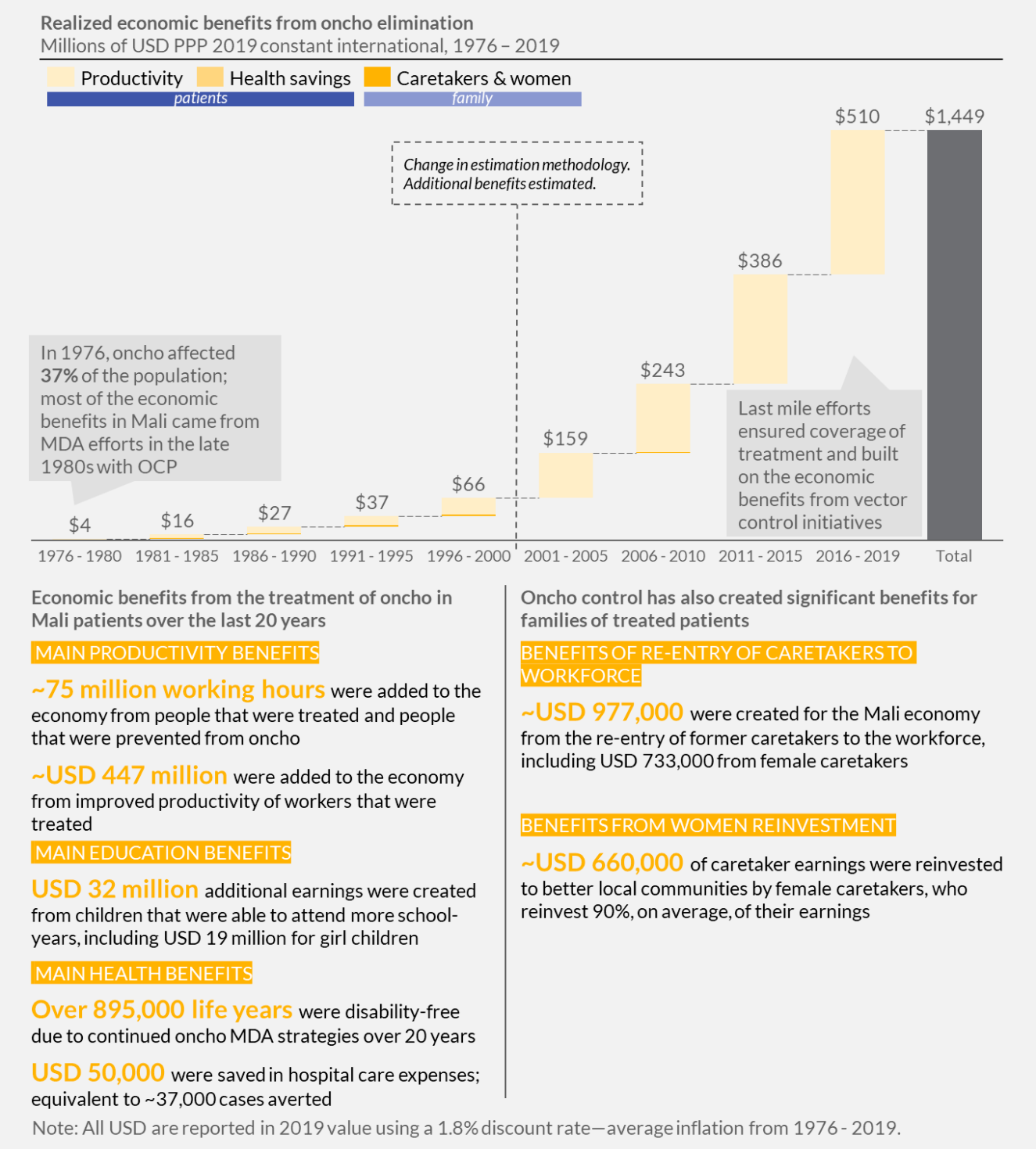
Mali integrated its NTD program in 2007 and prioritized local ownership of programming design. Before 2007, the fight against NTDs in Mali was carried out through “independent and vertical” programs for each disease.⁴² In 2007, USAID funding supported Mali to integrate its MDA approach. The integrated control program was led by the MoH and coordinated by a national NTD control program. This integrated approach relied on a situation analysis, mapping disease distribution by district to identify overlaps in disease burden, and a localized strategy to design a program approach based on known prevalence and WHO guidelines. The strategy focused on strengthening ownership of programming by local structures and improved coordination.

Mali is nearing elimination of oncho using a combination of early vector control and MDA. Vector control efforts began in 1977 under OCP and while control was achieved, elimination was not. Mali began using MDA with ivermectin in 1987, conducted through mobile teams and later through community-directed treatment with ivermectin.⁴³ As of 2018, 34 of 75 health districts were classified as endemic for oncho; of these health districts, only 20 still require active MDA treatment.⁴⁴

Mali’s LF elimination efforts are led by the GPELF strategy of MDA with ivermectin. All health districts in Mali were endemic for LF, based on mapping by PNEFL in 2004. Ivermectin and albendazole distribution began in 2004.⁴⁵ By 2009, treatment coverage reached 100%; in 2012, due to security concerns in the northern region, treatment was interrupted for ~2 years. By 2017, 16 of 75 still required treatment as LF had been controlled in all other districts.⁴⁶

Mali has created an estimated USD 2.6 billion in economic benefits due to oncho and LF elimination efforts. The country added over ~125 million working hours and USD 1.2 million to GDP from improved productivity of workers that were treated. Families of NTD-infected people were able to rejoin the workforce adding an estimated USD 2.7 million to GDP and investing USD 1.8 million back into their communities.

Figure 8: Economic benefits from oncho elimination efforts in Mali



⁴² M. Dembele et. al, "[Implementing Preventive Chemotherapy through an Integrated National Neglected Tropical Disease Control Program in Mali](#)," 2012

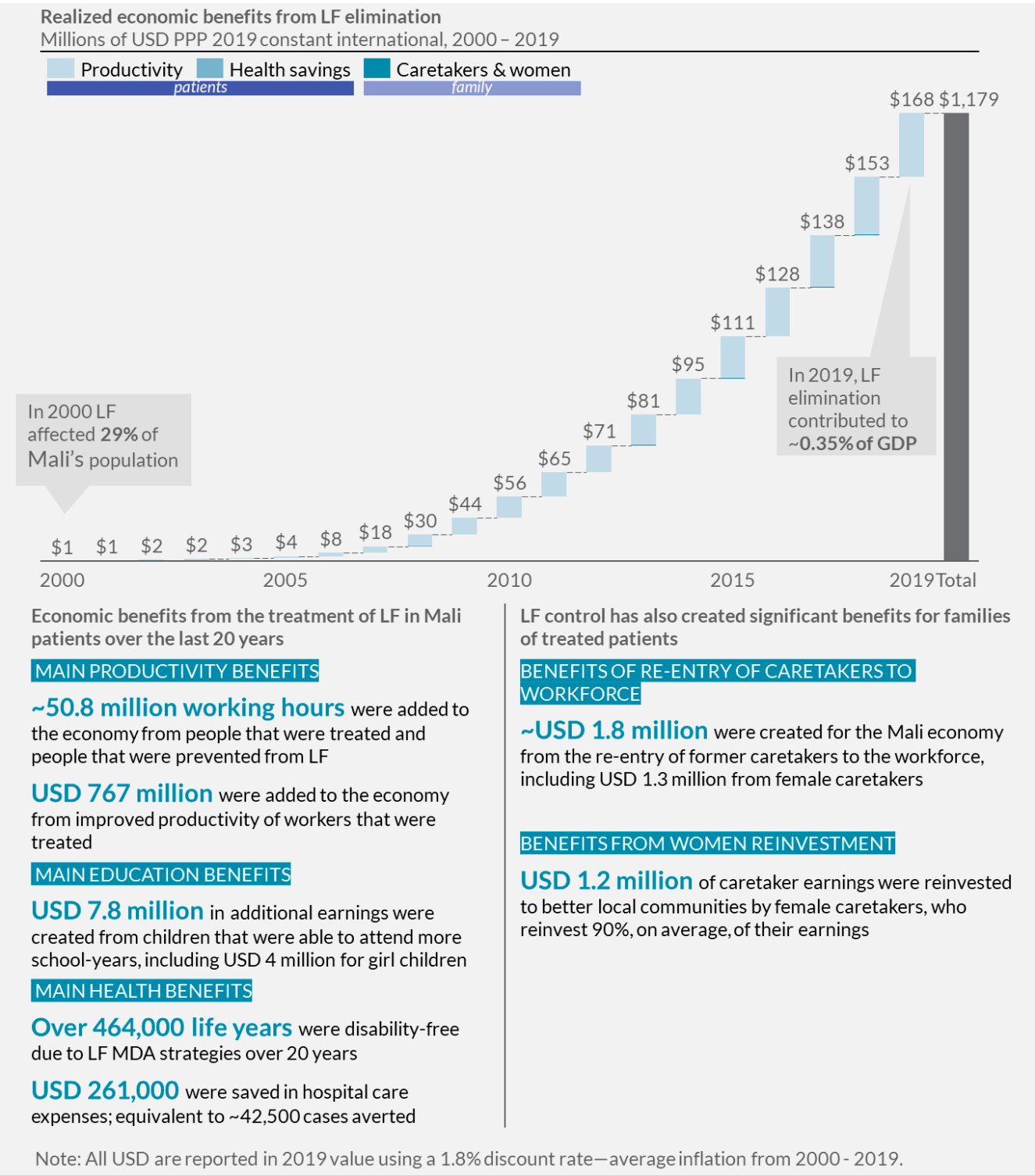
⁴³ Dolo et al., "[Serological Evaluation of Onchocerciasis and Lymphatic Filariasis Elimination in the Bakoye and Falémé Foci, Mali](#)", 2020

⁴⁴ USAID, [Act to End NTD West Report FY2019](#)

⁴⁵ Dolo et al., "[Serological Evaluation of Onchocerciasis and Lymphatic Filariasis Elimination in the Bakoye and Falémé Foci, Mali](#)", 2020

⁴⁶ [Mali NTD Master Plan](#) 2017-2021

Figure 9: Economic benefits from LF elimination efforts in Mali



Ethiopia

Ethiopia integrated its NTD program in 2013 and prioritized community empowerment in its NTD Master Plans. Before 2013, NTD specific interventions existed but there was no coordinated national approach. The data on the burden and distribution of NTDs were incomplete and access to preventative and curative services were inadequate. Ethiopia launched the first NTD Master Plan in 2013, followed by a second in 2016, and included NTDs in the country's 5-year Health Sector Transformation Plan in 2015.⁴⁷ Ethiopia's NTD elimination strategy focused on community empowerment. The Health Extension Program was launched to educate, mobilize, and involve the community in all stages of control and elimination efforts. The program distributed social behavior change communication materials that were developed to address specific gaps at the community level. In addition, the NTD strategy was integrated with cross-cutting interventions, such as capacity building for surgery skills at district hospitals, WASH interventions, and insecticide nets and sprays to prevent malaria.⁴⁸

Ethiopia used MDA to drive elimination efforts of oncho, beginning in 2001. The national approach began in 2001 with an annual treatment of hyper-endemic and meso-endemic districts. Since 2012, strategies have targeted all endemic districts with preventative chemotherapy via MDA with ivermectin. Albendazole is integrated in MDA depending on the endemicity of soil-transmitted helminths in the district.

Ethiopia's LF elimination efforts have gradually expanded over time. Initial mapping surveys from 2008 were conducted in 112 districts of western Ethiopia and collected detailed information on the prevalence of LF-associated morbidities. Annual MDA for LF has been implemented since 2009 in 5 districts, alongside the ongoing oncho control efforts. By 2013, the coverage area was expanded to include 28 districts.

Ethiopia has created an estimated USD 1.1 billion in economic benefits due to oncho and LF elimination efforts. The country added over ~48 million working hours and USD 683 million to GDP from improved productivity of workers that were treated. Families of NTD infected people were able to rejoin the workforce adding an estimated USD 1.5 million to GDP and investing USD 1.05 million back into their communities.

⁴⁷ [Ethiopia NTD Master Plan 2016-2020](#)

⁴⁸ Meribo et al., "[Review of Ethiopian Onchocerciasis Elimination Programme](#)", 2017

Figure 10: Economic benefits from oncho elimination efforts in Ethiopia

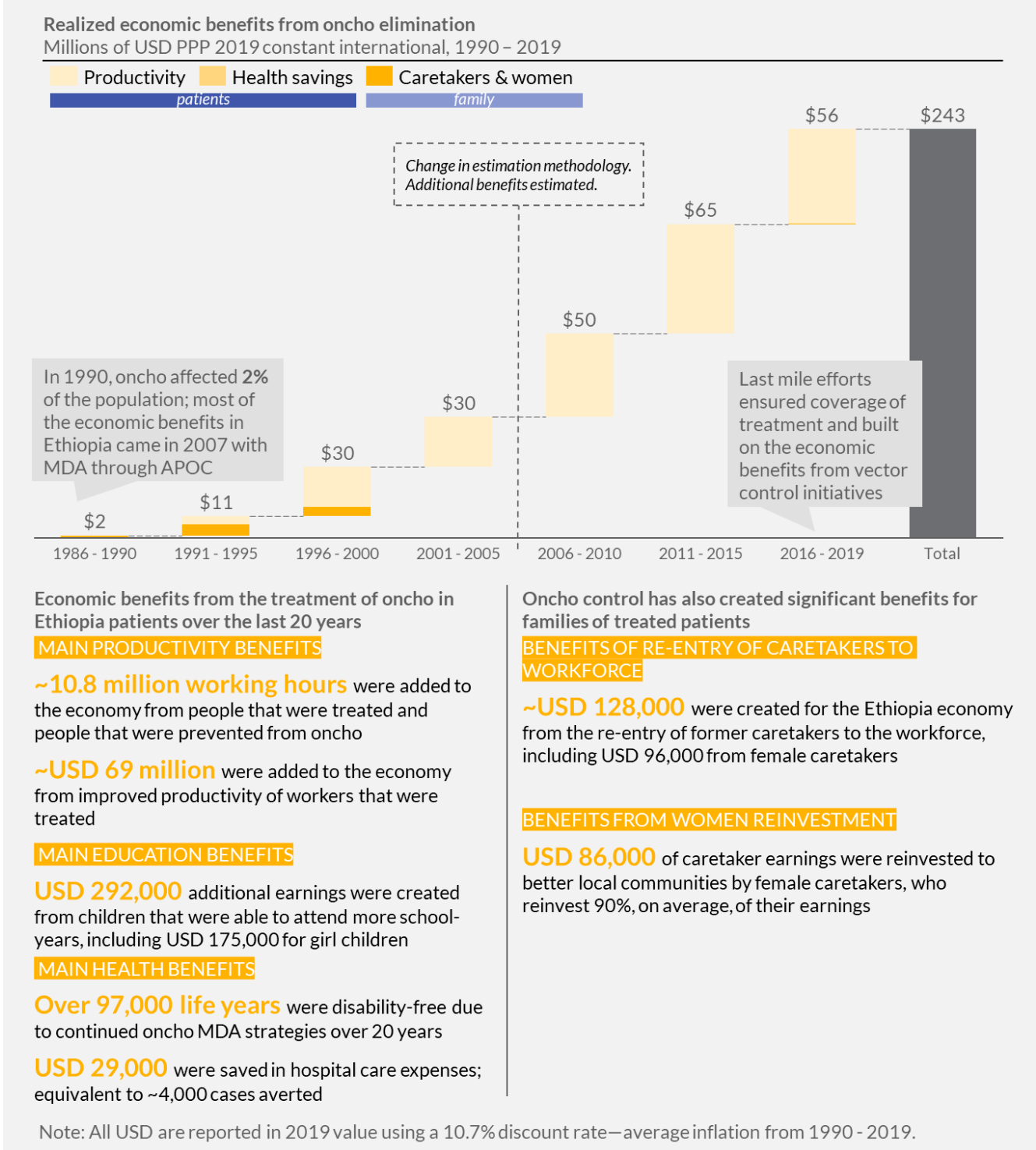
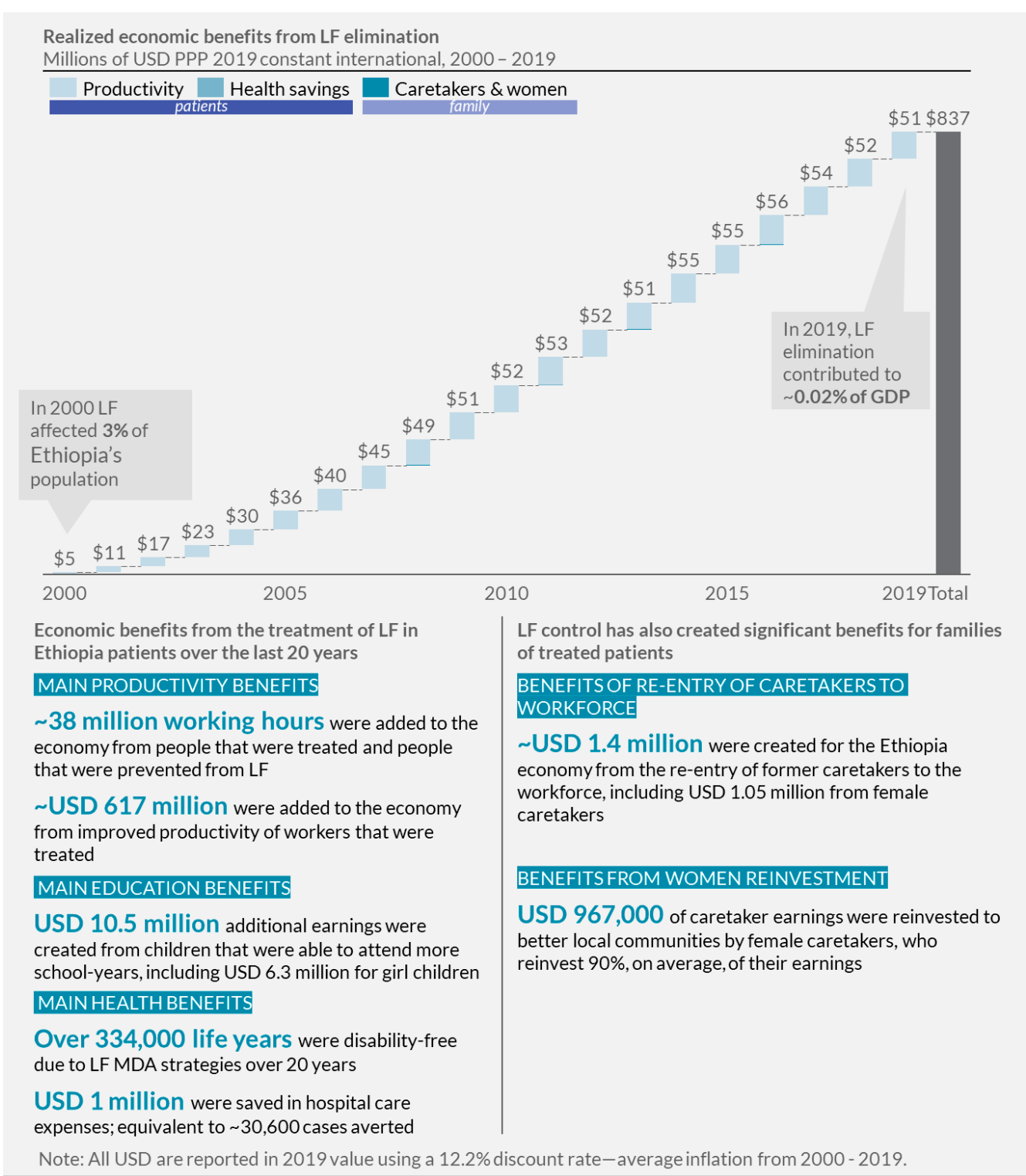


Figure 11: Economic benefits of LF elimination efforts in Ethiopia



METHODOLOGY

Productivity, health, and co-benefits were each determined through a combination of demographic, prevalence, and regional literature values. Key assumptions were made due to a lack of data or for simplification of the modelling exercise’s depiction of real-world behaviors. Several assumptions were tested through a series of sensitivity analyses, leading to the conclusion that the model is highly sensitive to two input variables: GDP per capita and caretaker’s likelihood of seeking and obtaining employment.

Calculations of economic benefits

Data is scarce on several dimensions of NTD economic benefits: NTD-specific health system usage, sequelae prevalence distributions within a country, and caretaker behaviors post-treatment of their family members. Figures 13 and 14 provide additional details on the calculation of productivity benefits, health benefits, and co-benefits. Each data element within the calculation is tagged based on data availability and applicability:

- Data is available and relevant to the country and/or context of NTDs
- Data is available and evidenced, but may lack specific context to NTDs
- Data is not available that is specific to the country and/or context of NTDs. A regional or global value was used in the calculation.

Figure 12: Productivity benefits calculations

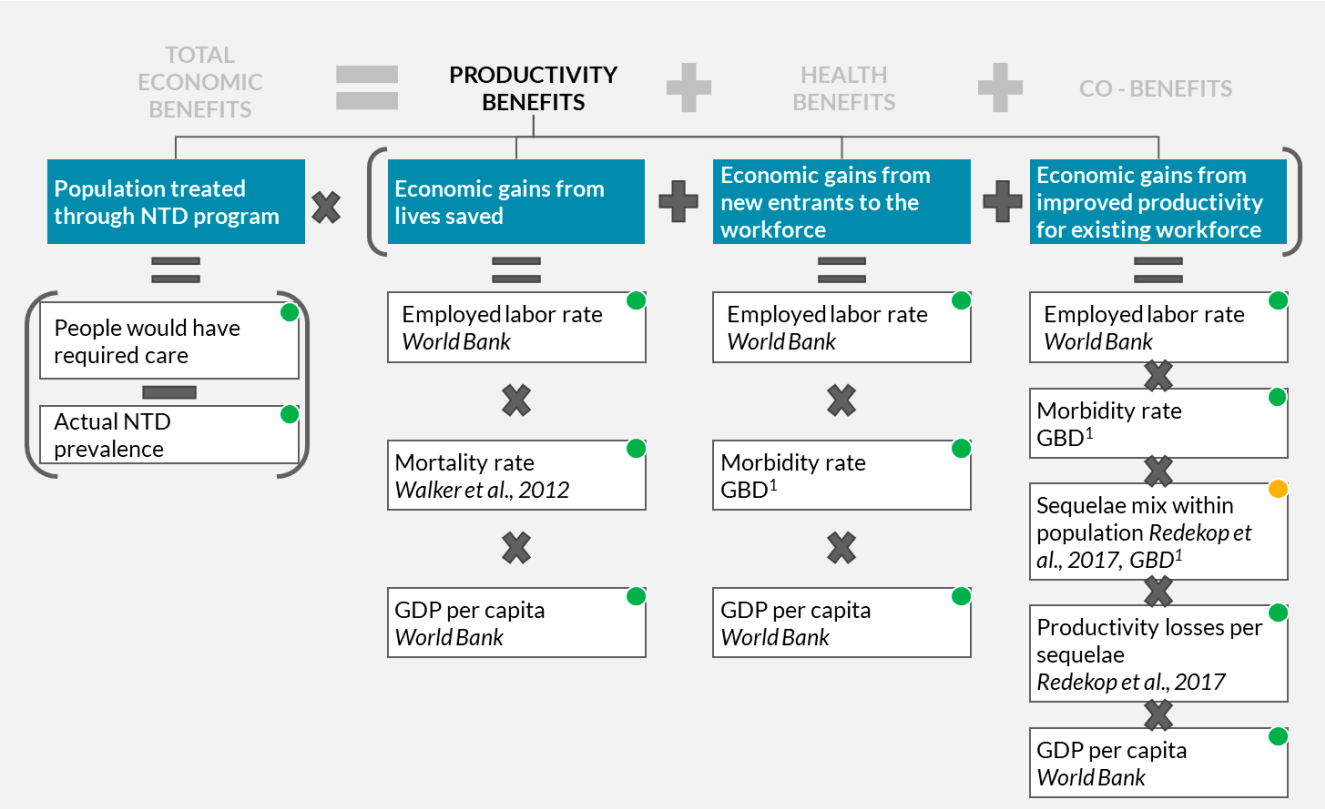
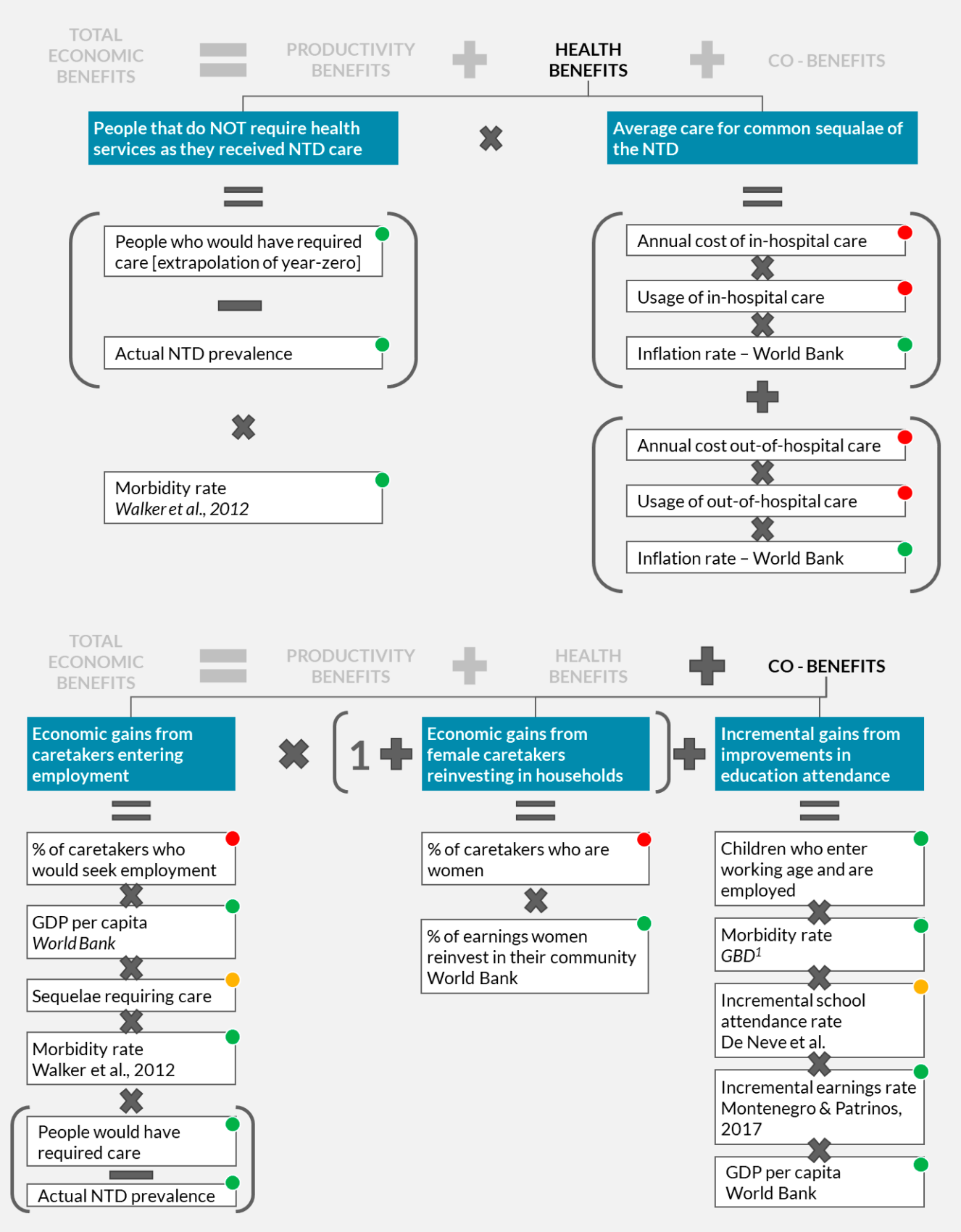


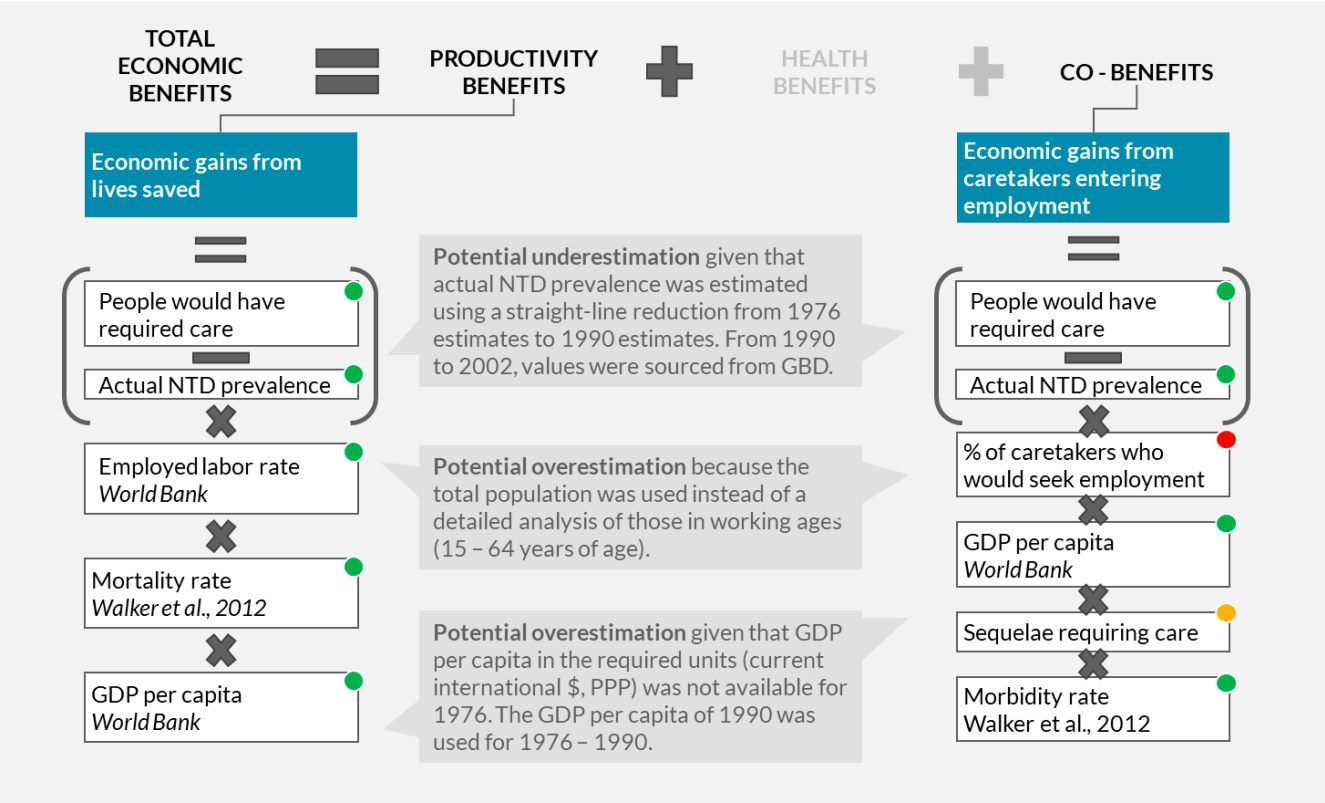
Figure 13: Health benefits and co-benefits calculations



Due to a lack of detailed historical data, the calculations of economic benefits from oncho elimination efforts for the period prior to 2000 was conducted using a simplified model relying on population and prevalence data, with less granularity. The estimation of economic impact for 1976 – 1999 selects the two largest segments of the full economic model; the simplified model excludes health benefits and several benefits under productivity and co-benefits. This captures ~64% of total economic benefits calculated in the detailed estimates.

For Niger, Senegal, and Mali, this simplified model was used for economic benefits from 1976 to 1999; for Ethiopia, the simplified model was used from 1990 to 1999. Figure 14 provides the calculations underlying the simplified economic benefits model and highlights the implications on magnitude.

Figure 14: Simplified economic benefits calculations for 1976-1999



Assumptions

Most health-sector data reflects national averages and the effects on the formal economy. The population most affected by NTDs, as stated earlier, typically belongs to the poorest communities in rural geographies. According to experts, these individuals engage in primarily informal economic opportunities. A number of assumptions were made due to the lack of available data on these communities.

There are 6 key assumptions underlying the economic benefits model. Each assumption is based on literature review and expert interviews. For assumptions due to a lack of data, or conflicting data, sensitivity analyses were conducted and reflected that the model was most sensitive to (i) changes in individual annual income; and (ii) caretaker behaviors.

1. **The GDP per capita of the lowest income quintile captures the likely earning potential and contribution to GDP of the population most directly affected by NTDs.** As a proxy for income and earnings, GDP per capita was used; but given the prevalence of NTDs amongst the poorest in a country, the average GDP per capita would have been a gross overestimation. Shifting from an average to the earnings potential of the lowest income quintile assumes that there is no economic mobility in a country. Experts felt strongly that economic mobility is severely restricted within this population and that use of the lowest income quintile would reflect the opportunities available to treated individuals.
2. **The rural unemployment rate reflects the paid economic opportunities available to the population most directly affected by NTDs.** A national average unemployment rate would conflate urban and rural paid employment. Most individuals affected by NTDs live in rural areas and, in the countries reviewed, are largely part of the agrarian economy. There is often more informal labor opportunities available in agrarian areas.
3. **Productivity losses associated with oncho and LF may be different than those used, because productivity in the formal vs. informal economy is likely different.** Productivity losses associated with each sequelae (symptom) of oncho and LF are based on individuals employed in the formal economy. According to multiple experts, it is unclear in which direction to adjust productivity for the informal sector. Some research indicates that disability would decrease productivity more if employed in the agriculture sector; others argue that formal employment requires a limited set of physical capability so disability would cause more loss in the agriculture sector. As a result of this discourse, a sensitivity analysis was conducted to capture productivity losses 10% higher and 10% lower than evidenced in Redekop et al.
4. **School-age children attend more school after being treated for an NTD.** NTDs are not the only barrier to education in most communities reviewed; however, research on deworming in Kenya indicates that students may attend more school after an intervention.⁴⁹ Experts reiterated that assuming full participation in school after an NTD treatment would overstate benefits. As a result, the analysis conducted here uses a proxy

⁴⁹ Baird et al., “[Twenty year economic impacts of deworming](#),” 2020

of “additional years of school attended” and a baseline school enrollment rate—the country’s gross primary school enrollment.

- 5. **Men and women are equally impacted in terms of schooling and employment earnings for those already in paid employment.** Literature and experts indicated that women likely have a higher unemployment rate than men; and girl children are less likely to return to school or attend additional school given societal norms in the region. Due to a lack of detailed data on the impact of NTDs for each gender, demographic data was used to determine a roughly equal distribution of productivity and education benefits.
- 6. **Caretakers are less likely to return to paid work than the average unemployed individual, and when they do, they typically are employed in the informal economy.** Following treatment of an individual, the caretaker formerly responsible for the individual will have the opportunity to seek employment. Experts indicated that the impact of caretakers returning to work is likely low – and that caretakers are likely to take low-paying, informal jobs. As a result, the proportion of caretakers returning to the workforce is based on the proportion of the labor force that is engaged in non-subsistence agriculture.

Based on the assumptions outlined above, the following sources were used for each variable in the economic assessment.

Variable	Source
Population demographics	Population reference bureau, World Bank
Labor force participation rate	ILO
Rural unemployment rate	ILO
GDP per capita	World Bank
Income distribution	ILO/World Bank
Mortality rate	Walker et al., 2012
Morbidity rate	Global burden of disease
Sequelae associated productivity losses	Redekop et al., 2017
Sequelae prevalence	Redekop et al., 2017
Proportion of earnings reinvested by women	Yong Kim, 2018; World Bank
School enrollment rate	World Bank
Incremental earnings per additional year of school	OECD, Montenegro & Patrinos, 2017

Sensitivity analyses

Sensitivity analysis was conducted across 4 variables with data that is specific to the country and/or context of NTDs is not available and a regional or global value was used in the calculation. This analysis is conducted for Niger; but the sensitivity (%) of the benefits is consistent across countries.

- 1. **Productivity losses associated with each sequelae.** Estimated at 90% and 110% of the original productivity loss figures, total productivity benefits changed by 3% and total economic benefits changed by approximately 3%
- 2. **Healthcare costs of in-hospital and out-of-hospital care.** Estimated at 25% and 200% of original costs, total economic benefit was not sensitive to healthcare costs or the proportion of costs incurred by the government – less than 1% change. This is due to the relatively low health service-seeking behavior of oncho and LF patients.
- 3. **Proportion of caretakers who are female.** Estimated at 10% higher and 10% lower than original estimations of 75%, total economic benefits was not sensitive to the proportion of caretakers who were female – less than 1% change.
- 4. **Proportion of caretakers who can re-enter workforce with paid employment.** Estimated at 50% lower and 50% higher than original estimate of 10%, based on the 90% of Niger’s population engaged in subsistence farming. The total economic benefit is sensitive to the employability of caretakers and particularly the availability of paid employment opportunities for former caretakers. Total economic benefits changed by 10%; and earning and reinvestment benefits changed by 50%.

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