Addressing the Caregiving Crisis

Gender-Transformative Global COVID-19 Recovery Plan

JUNE 2021

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Gender-Transformative Global
COVID-19 Recovery Plan

Why It Matters

Covid-19 Has Laid Bare Gendered Divides Globally

The COVID-19 pandemic is a once-in-a-century crisis. Well over 3 million people have died as of June 2021 and entire economies have been disrupted in ways previously unimaginable. This global pandemic further reinforces how crises shine a light on the many ways in which gender norms and gendered practices disproportionately burden women and girls.

The pandemic has deepened gender inequalities and reinforced gender stereotypes, with women and girls bearing the brunt of care work and disruptions in education and employment. Compared to men and boys, they face poorer access to health and other essential services, and greater risk of intimate partner violence, being dispossessed of land and property, and digital and pay divides.

The economic fallout of COVID-19 has disproportionately affected sectors with large female workforces, including **retail, hospitality, and healthcare**.

Women have been disproportionately burdened by **caregiving responsibilities,** with children out of school and family members falling ill, which also has negative knock-on effects in terms of current and future workforce participation.

Child marriage and early unions are projected to increase, particularly among the poorest families seeking to reduce their household size and spending.

These developments threaten to **expand the gender wealth gap** and set countries back years in terms of gender equality.
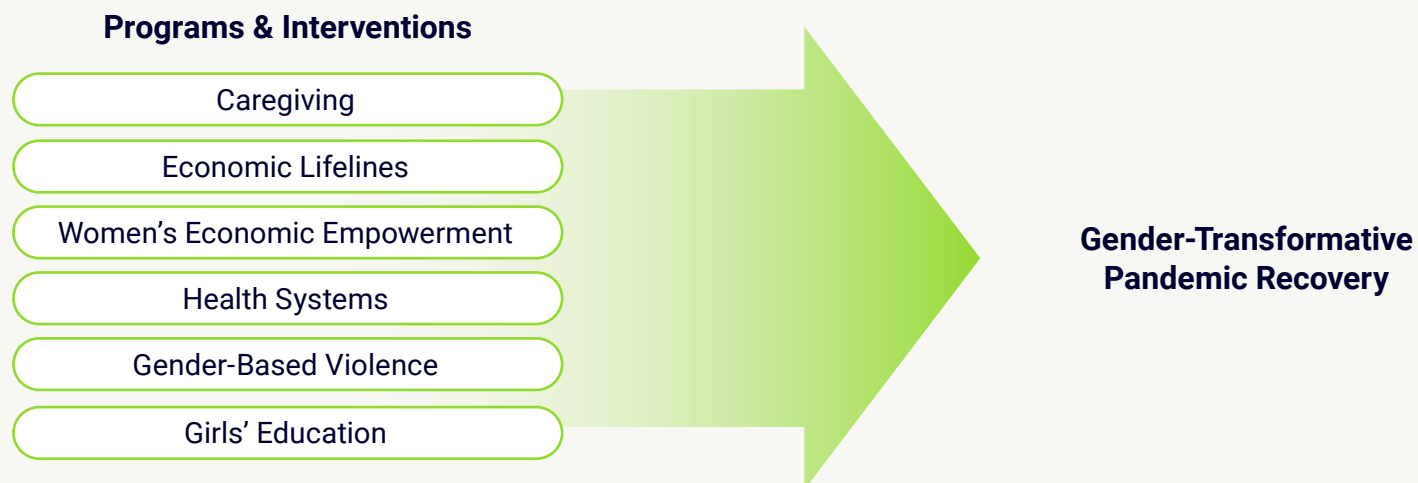
From Crisis Comes Opportunity

Despite these challenges, there are signs of hope for a more equitable post-COVID world, with countries recognizing a need to invest in childcare and gender-based violence prevention like never before. After years of advocacy by local and global civil society and women's rights groups, there is a growing understanding that deep societal change is needed to build more equitable societies.

The global community—led by the G7 and G20 and supported by the World Bank and regional multilateral development banks (MDBs)—has a momentous opportunity to launch a Gender-Transformative Global COVID-19 Recovery Plan. Such a recovery must incorporate, at minimum, investments in programs proven to empower women and girls through not just individual, but societal change. Collectively, this approach of

supporting multi-dimensional programs and interventions will drive a pandemic recovery that helps countries build back better and contribute to a more equitable and prosperous future for all women and girls, as well as to broader economic benefits for societies overall. By some estimates, pursuing gender-intentional and equitable programs and policies now could add $13 trillion to global GDP in 2030.[1]

Gender-Transformative Policy Framework

Programs & Interventions

- Caregiving
- Economic Lifelines
- Women's Economic Empowerment
- Health Systems
- Gender-Based Violence
- Girls' Education
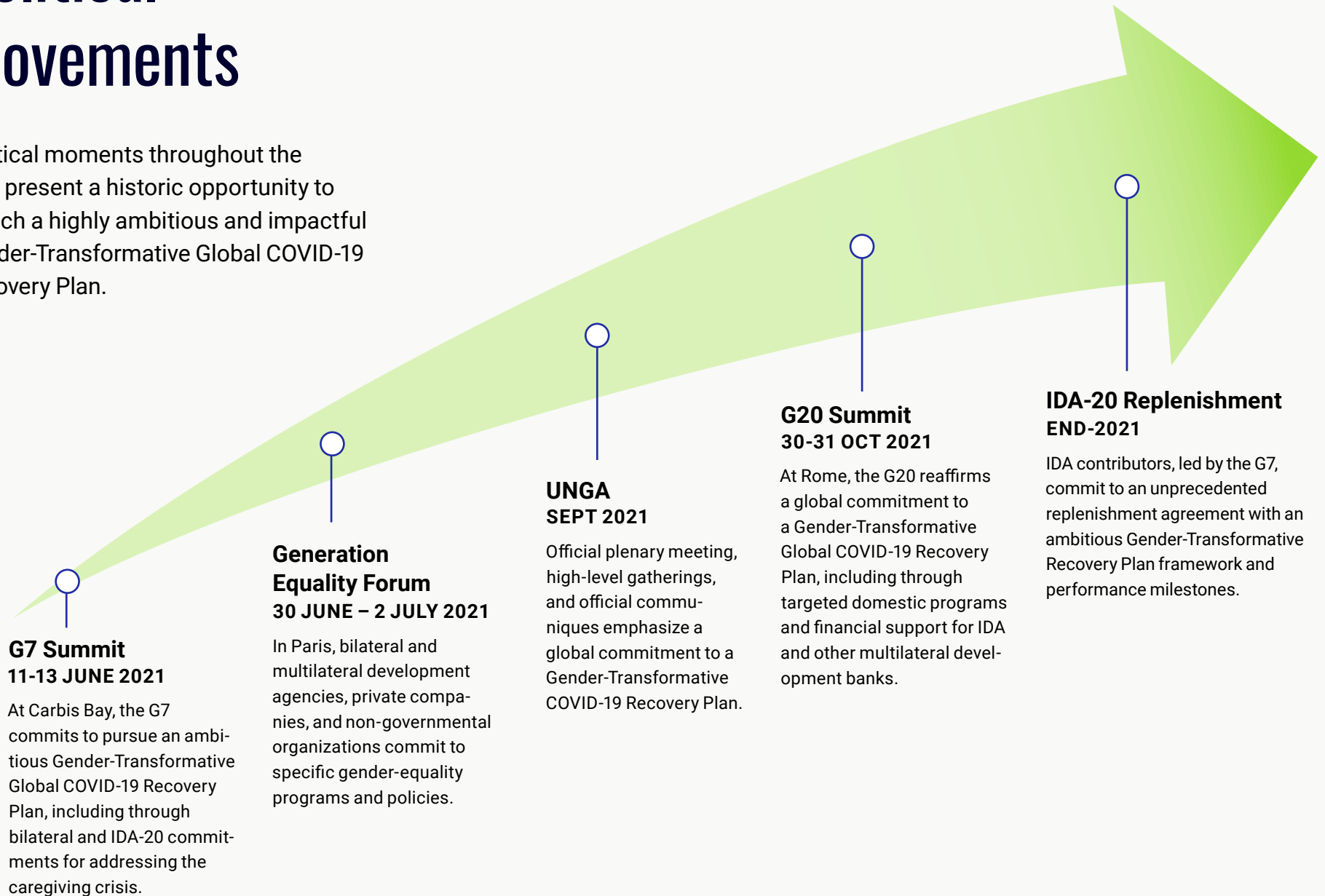
Gender-Transformative Pandemic Recovery

Note 1: Madgavkar, Anu, et al. "COVID-19 and Gender Equality: Countering the Regressive Effects." *McKinsey & Company*, McKinsey & Company, 15 July 2020, www.mckinsey.com/featured-insights/future-of-work/covid-19-and-gender-equality-countering-the-regressive-effects.
Source: Fraym

Political Movements

Political moments throughout the year present a historic opportunity to launch a highly ambitious and impactful Gender-Transformative Global COVID-19 Recovery Plan.

G7 Summit
11-13 JUNE 2021

At Carbis Bay, the G7 commits to pursue an ambitious Gender-Transformative Global COVID-19 Recovery Plan, including through bilateral and IDA-20 commitments for addressing the caregiving crisis.

Generation Equality Forum
30 JUNE – 2 JULY 2021

In Paris, bilateral and multilateral development agencies, private companies, and non-governmental organizations commit to specific gender-equality programs and policies.

UNGA
SEPT 2021

Official plenary meeting, high-level gatherings, and official communiques emphasize a global commitment to a Gender-Transformative COVID-19 Recovery Plan.

G20 Summit
30-31 OCT 2021

At Rome, the G20 reaffirms a global commitment to a Gender-Transformative Global COVID-19 Recovery Plan, including through targeted domestic programs and financial support for IDA and other multilateral development banks.

IDA-20 Replenishment
END-2021

IDA contributors, led by the G7, commit to an unprecedented replenishment agreement with an ambitious Gender-Transformative Recovery Plan framework and performance milestones.
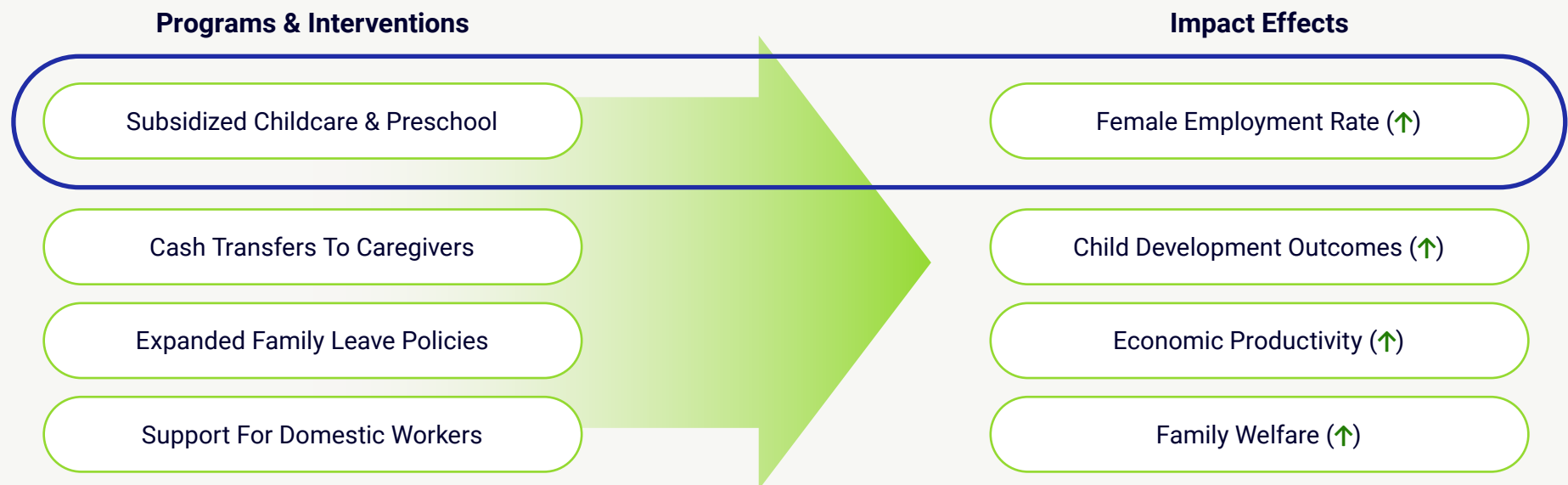
Caregiving Intervention Policy & Impact Framework

In this report, we focus on one pillar of the proposed Gender-Transformative Global COVID-19 Recovery Plan. Specifically, we focus on the global caregiving crisis and analyze how programs targeted at caregivers of children can accelerate an equitable recovery and employment opportunities for women. Such programs can help reduce the burden of unpaid care work, allowing women, households, and countries overall to benefit through greater economic activity, growth, and social inclusion.[1] This includes simulations that illustrate a range of potential impacts if targeted programs were launched in Nigeria, Senegal, South Africa, and Uganda.

Caregiving Intervention — Policy and Impact Framework

Programs & Interventions

- Subsidized Childcare & Preschool
- Cash Transfers To Caregivers
- Expanded Family Leave Policies
- Support For Domestic Workers

Impact Effects

- Female Employment Rate (↑)
- Child Development Outcomes (↑)
- Economic Productivity (↑)
- Family Welfare (↑)

Note 1: For example, a 2020 McKinsey report builds on the McKinsey Global Institute's (MGI's) Power of Parity work to estimate that taking action now could increase 2030 GDP by $13 trillion relative to the "do-nothing" scenario. A 2016 report using the same Power of Parity work finds that the economic benefits of narrowing gender gaps are six to eight times higher than the social spending required.
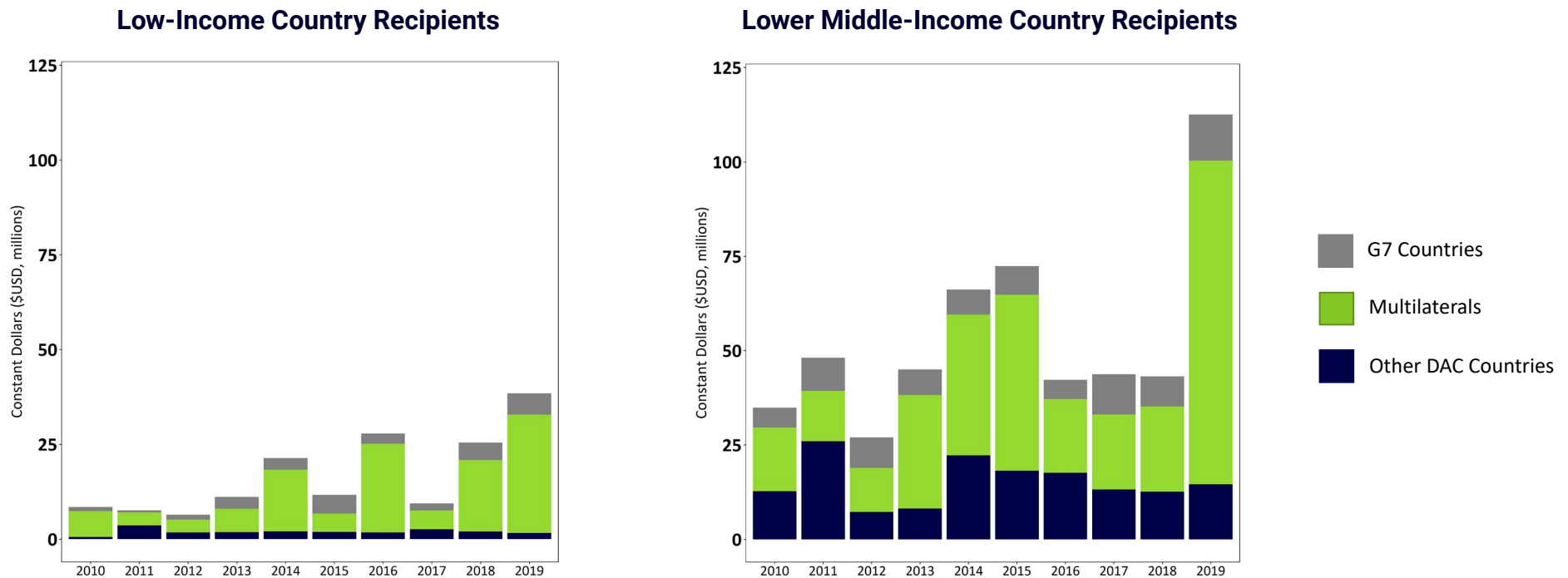
Bilateral & Multilateral Support

Past Funding

Over the last decade, multilateral and bilateral donors have increased investments in early childhood development (childcare and preschool) programs. These programs have shown promise and have the potential to be scaled significantly through a Gender-Transformative Global COVID-19 Recovery Plan.

## Early Childhood Development ODA Disbursements — Multilateral Agencies, G7 Countries, and Other DAC Countries

Low-Income Country Recipients

Lower Middle-Income Country Recipients

Legend:
- G7 Countries
- Multilaterals
- Other DAC Countries

IDA Support

IDA has been the largest supporter of early child-hood development programs, accounting for nearly 40 percent of all related donor assistance over the last decade.

Early Childhood Development ODA Disbursements — G7 Countries and IDA
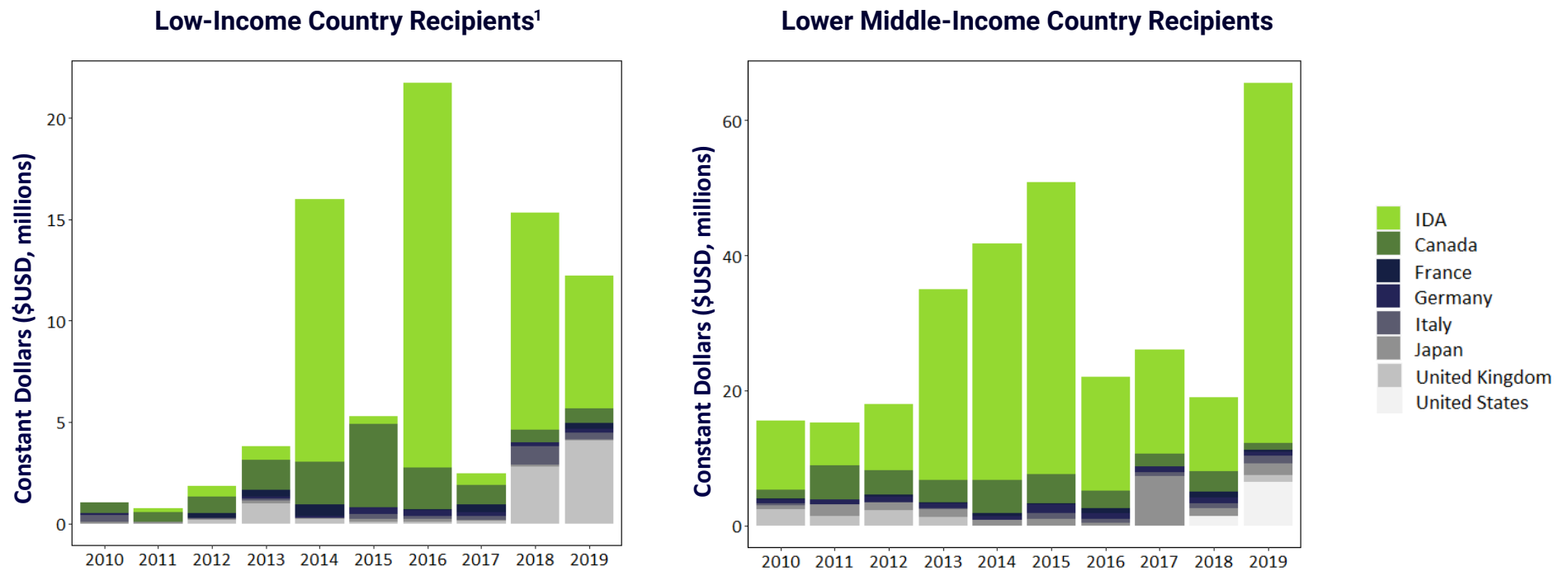
Low-Income Country Recipients[1]

Lower Middle-Income Country Recipients

Legend: IDA, Canada, France, Germany, Italy, Japan, United Kingdom, United States

Country Simulations

a. Approach & Methods

b. Nigeria

c. Senegal

d. South Africa

e. Uganda

Approach

Fraym has simulated the potential effects of measurable, actionable, and effective programs that would be targeted at addressing the care-giving crisis. These simulations apply a range of assumptions drawn from peer-reviewed studies as well as sequencing of programmatic coverage based upon initial rollout opportunities and constraints. Longer-term opportunities to deliver fully scaled up and sustainable program coverage for all target beneficiaries including traditionally marginalized groups are considered and presented as well (e.g., "Path to 2030 & beyond").

MEASURABLE

ACTIONABLE
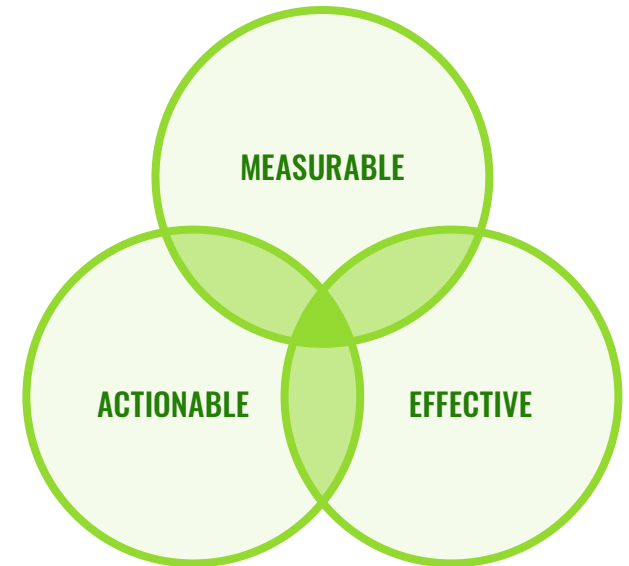
EFFECTIVE

1 To pursue the simulation, Fraym identified policies that are *measurable* (including through existing national household surveys), *actionable* and well-studied by the policy and global development communities, and found to be *effective*. Fraym selected subsidized childcare and pre-school as the exemplar intervention.

2 Upon identifying an intervention for simulation, Fraym defined the **target population** (e.g., all individuals or households eligible for the program) and the **outcome of interest**, (e.g., most common impact indicator) based upon a broad range of peer-reviewed studies of related caregiving interventions in developing countries.

3 To simulate the policy at a national level, **Fraym considered a range of effect sizes**, recognizing the challenges with external validity and scaling interventions to full coverage of target beneficiaries. Fraym then applied assumptions to initial- and longer-term rollout impact effects. **The range of impact generally can be considered as the best a country could do if such a policy was fully scaled up and applied to all respective eligible beneficiaries.**

4 Using the effect from prior studies, Fraym estimated the projected impact of the programmatic intervention. The long-term projections reflect an aspiration of fully scaled up coverage across all target beneficiaries within the entire country, whereas **initial rollout projections focus on a sub-set of all target beneficiaries in a way that may reflect near-term fiscal, capacity, and operational constraints.**

Selected Exemplar Intervention

Academic studies have consistently found that childcare and preschool delivery or related support programs yield positive impacts for mothers can increase female employment rates generally by between 8 and 22 percentage points.[1]

Country	Program Name	Program Description	Impact (Female Employment)
Kenya	Randomized controlled trial	1,222 women living with children 1-3 years old in a slum of Nairobi were randomly assigned to a control group or a treatment group consisting of subsidized childcare in the area.	8.5 percentage point (pp) increase[1]
Brazil	Public preschool lottery	Rio de Janeiro has a public early childhood development program for children 0-3 years old from low-income neighborhoods. Every year 10,000 slots are offered in a lottery style.	8-10 pp increase[2,3]
India	Integrated Child Development Services (ICDS)	Social program launched in India in 1975 providing a host of services to households with young children including nutritional supplementation, immunization, and education. All children 3-6 years old are eligible for pre-school services through ICDS, though supply constraints exist.	2-12 pp increase[4]
Mexico	Estancias	The Estancias program provides community- and home-based daycare to target children 1-3 years old from low-income households whose mothers work in the informal economy and therefore do not receive social security.	18-21 pp increase[5,6]
Argentina	Public preschool expansion	In the 1990s, Argentina constructed thousands of new classrooms, among them public preschools for children 3-5 years old. The asynchronous construction across the country has allowed researchers to assess the causal impact of construction on different metrics.	7-14 pp increase[7]
Ecuador	Fondo de Desarrollo Infantil (FODI)	Started in 2005, FODI is the largest public provider of preschool in Ecuador and targets children aged 0-6 from low-income families. The program provides supervision, nutritional services, and educational services.	22 pp increase[8]
Colombia	Hogares Comunitario de Bienestar (HCB)	Created in the 1970s, HCB is a government-funded program providing nutritional services and childcare to poor families with children aged 0-6.	12-38 pp increase[9]

Note 1: This programmatic effect range reflects the majority of examined peer-reviewed studies, with a small number of studies that find lower or much higher effects. In addition, Fraym reviewed the recently published study, *The impact of early childhood interventions on mothers* (https://science.sciencemag.org/content/372/6544/794), which finds that only a small number of studies analyze impacts on caregivers, but those that do often find positive impacts.
Source: Fraym. The subscripts for each study refer to endnote citations found in the appendix.

Methodology Details

Based on literature and available data, Fraym has estimated the potential impact of investing in early childcare and preschool interventions in several focus countries. The impact simulations focus on female employment rates specifically, while recognizing that caregiving-related programs have multiple economic and social returns. Investing in such programs will contribute to broader societal benefits including household well-being and economic growth.[1]

STEP 1

Target Population

Across peer-reviewed interventions, program eligibility was typically poorer households with exact income-related thresholds varying by country.

Drawing from these eligibility thresholds, we define the target beneficiary population as women (aged 15-49) who live in households:

- In the bottom two quintiles of the wealth index (urban-rural adjusted)[2]; and
- Have at least one child in the household aged six or younger.

Initial Rollout (Near-Term Targeting)

We consider a range of near-term feasibility factors, such as fiscal space, government delivery capacity, and concentration of beneficiaries. For these reasons, we focus on *one specific subgroup*—target beneficiaries living in urban areas (300+ people per square kilometer).

Path to 2030 (Long-Term Targeting)

For the long-term assumptions, we assume that all target beneficiaries would be reached effectively and sustainably, including traditionally marginalized groups.

Focus Outcome Indicator

The focus outcome indicator is female employment.[3]

STEP 2

Range of Effect Sizes

Based on peer-reviewed intervention program results, we consider the following effect size range:

- Lower bound: 8 percentage point increase; and
- Upper bound: 22 percentage point increase

STEP 3

Impact Projection

We simulate and then measure the potential increase in the number of working aged women who are employed at the national and first administrative division levels.[4]

We calculate these potential impact effects for the two distinct phases, including: (1) initial rollout for urban areas; and (2) a fully scaled programmatic application that reaches all potential target beneficiaries (e.g., households in the bottom two quintiles of the wealth index with at least one child aged six or younger).

Key Assumptions

The baseline female employment is a prepandemic figure and the true baseline considering pandemic job-losses may be lower.

Without differential effects available in the literature, Fraym assumes uniform impact.

Note 1: Previous cost-benefit analyses of early childhood interventions focus on the benefits for children, and often exclude the benefits of increased female labor force participation in their calculations. Thus, prior estimates should be considered a lower bound. For example, 2015 IADB study finds benefit-cost ratios of early childhood programs in a few Latin American countries are greater than 1. If these calculations included the benefits of female labor force participation, these interventions would likely look even more favorable.
Note 2: The wealth index is the DHS's own composite measure of a household's cumulative living standard.
**Note 3:** This outcome indicator is measured as women aged 15-49 who have worked in the past seven days. This includes both formal and informal work.
Note 4: We simulated and estimated potential impacts in the six focus countries where early childcare interventions are not already widespread (see appendix for details.)

# Target Beneficiary Population

In Nigeria, 26 percent of all working-aged women and girls (aged 15-49) meet the general eligibility definition and would be potential beneficiaries of a *fully-scaled up* early childcare-based caregiving intervention. Overall, this totals roughly 13 million women and girls, with particularly high concentrations in and around Kano.[1]

Percent of working-aged women and girls who are potential candidates for a caregiving intervention[2]

Total number of potential candidates for a caregiving intervention[2]

Abuja

Kano

Lagos

0   98%

0   200+
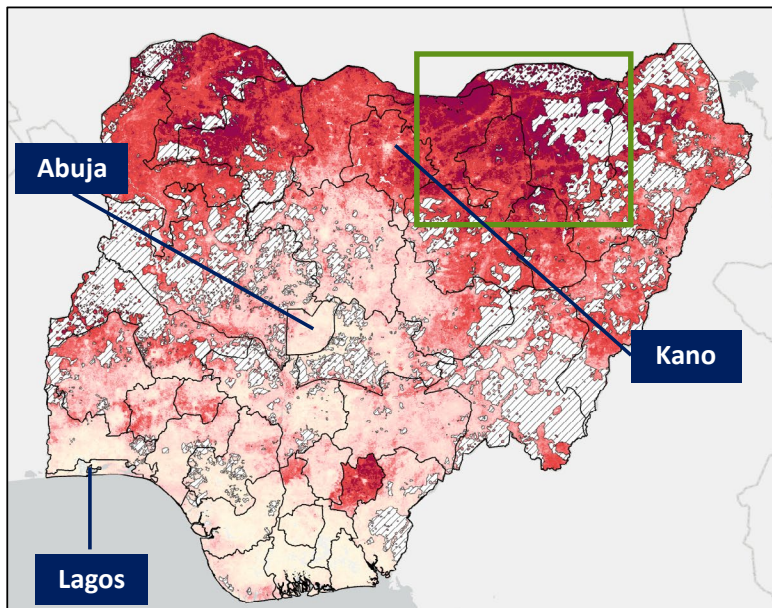
Areas with total population fewer than 30 people per sq km
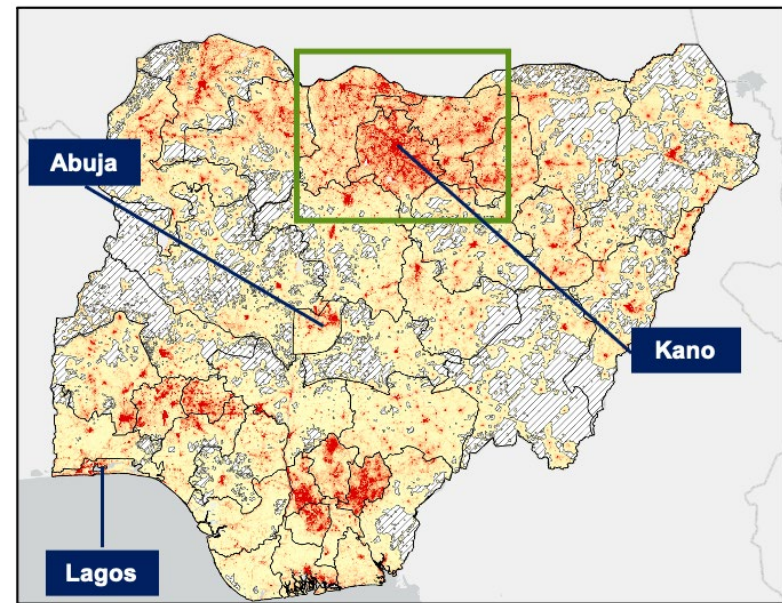
City   Large cities

Note 1: Of these 13 million, 7 million are located in urban areas (300+ people per km²) where rollout and take up of the program are most likely.
Note 2: Each 1 x 1 square kilometer grid shows the number of potential candidates, or the proportion of people who are potential candidates. Potential candidates are working aged women and girls (15-49) living in poor households (bottom 2 wealth quintiles) with a child 6 years or younger in the household. (Source: Fraym, 2018 DHS)

Estimating Potential Benefits

Based upon similar country program effect ranges, the *initial rollout* of a Nigerian program implemented in *urban areas only* could potentially increase female employment by between 560,000 and 1.5 million women.

Baseline (Pre-Intervention)[1]

Roughly 4.4 million of the initial rollout target population were already employed during the examined period. They are concentrated in Kano, Ebonyi, and Anambra states.
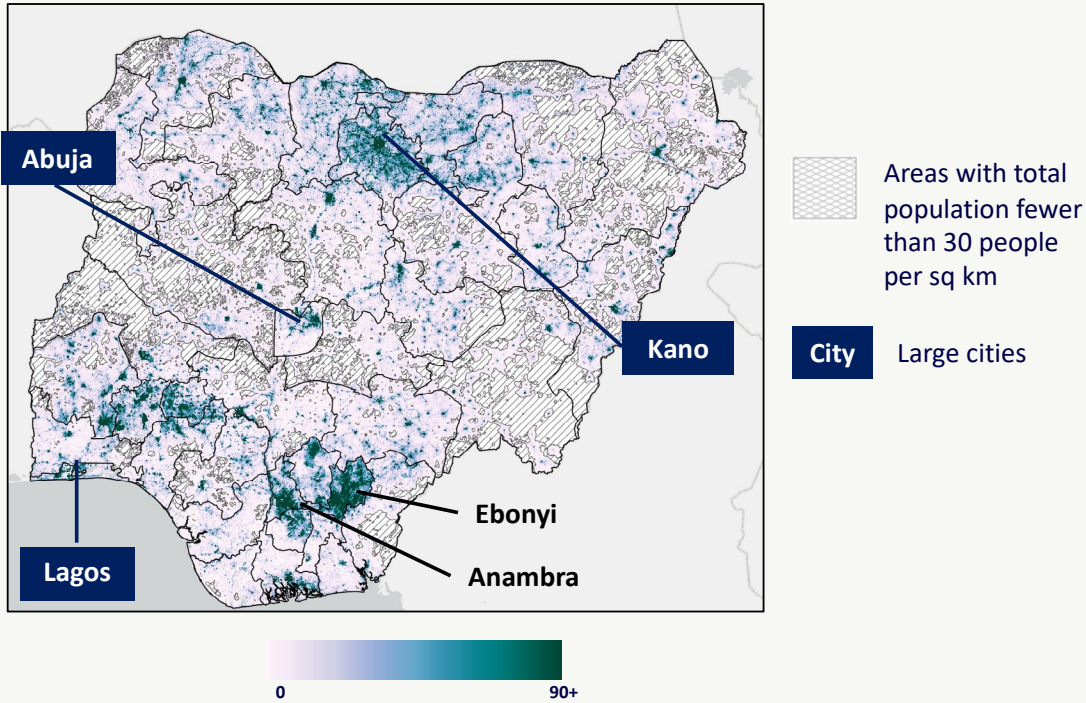
Areas with total population fewer than 30 people per sq km

City — Large cities

0 — 90+

Intervention Simulation

Target Population	Projected Impact
Initial Rollout	
Urban areas only	560,000 – 1.5 million more employed women
Fully Scaled Coverage ('Path to 2030 & Beyond')	
All target beneficiaries	1 – 3.3 million more employed women

Note 1: Each 1 x 1 square kilometer grid shows baseline female employment of the initial rollout target population. Please see slide 14 for more details. (Source: Fraym, 2018 DHS)

Potential Initial Rollout Sub-Targeting & Benefits

Decisionmakers may also want to consider focusing *initial rollout* in states with particularly large concentration of target beneficiaries such as Kano, Katsina, Jigawa, Sokoto, and Ebonyi.

Initial Rollout Projected Impact[1]
### Top Five States by Target Population
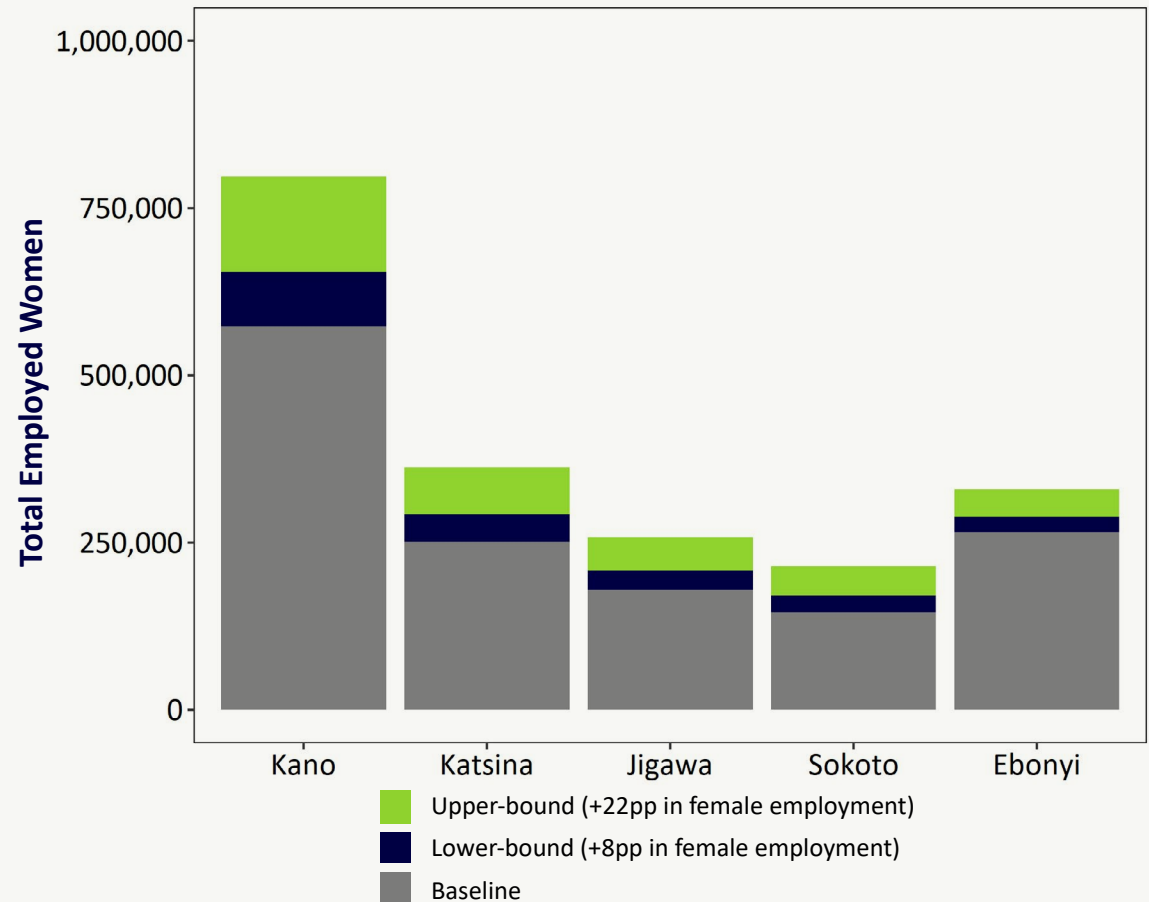
Legend:
- Upper-bound (+22pp in female employment)
- Lower-bound (+8pp in female employment)
- Baseline

Note 1: The height of each bar represents the total number of employed women at baseline, using the lower bound effect size, and using the upper bound effect size. The bars are ordered by initial rollout target population, with Kano having the largest.

Target Beneficiary Population

In Senegal, 31 percent of all working-aged women and girls (aged 15-49) meet the general eligibility definition and would be potential beneficiaries of a *fully-scaled up* early childcare-based caregiving intervention. Overall, this totals roughly 1.2 million women and girls, with concentrations in and the capital as well as the Kolda region.[1]

Percent of working-aged women and girls who are potential candidates for a caregiving intervention[2]

Total number of potential candidates for a caregiving intervention[2]

0   100%

0   130+
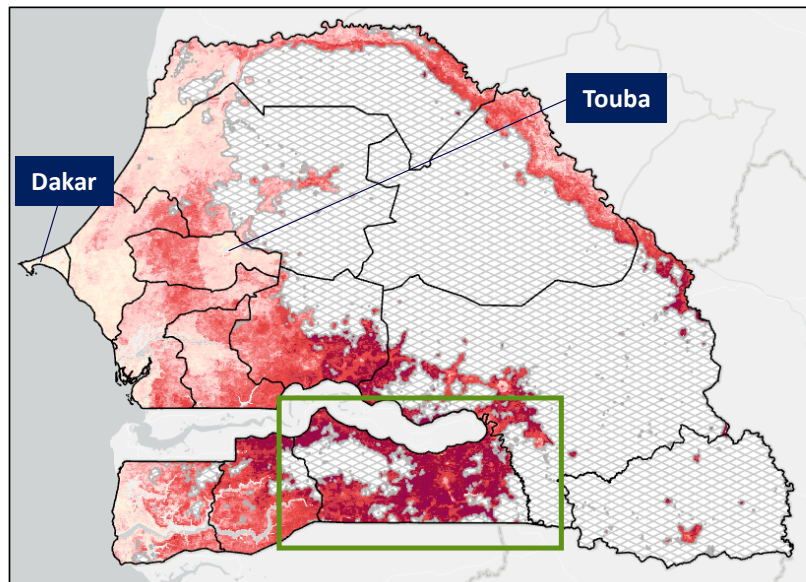
Areas with total population fewer than 30 people per sq km
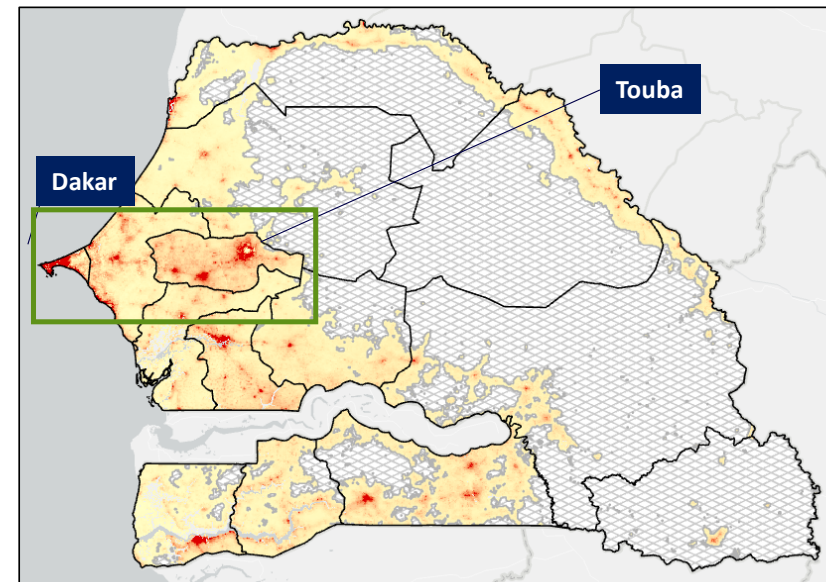
City   Large cities

Note 1: Of these 1.2 million, 330,000 are located in population dense areas (300+ people per km²) where rollout and take up of the program are most likely.
Note 2: Each 1 x 1 square kilometer grid shows the number of potential candidates, or the proportion of people who are potential candidates. Potential candidates are working aged women and girls (15-49) living in poor households (bottom 2 wealth quintiles) with a child 6 years or younger in the household. (Source: Fraym, 2019 DHS)

Estimating Potential Benefits

Based upon similar country program effect ranges, the *initial rollout* of a Senegalese program implemented in *urban areas only* could potentially increase female employment by between 26,000 and 73,000 women.

Baseline (Pre-Intervention)[1]

Roughly 150,000 of the initial rollout target population were already employed during the examined period and are likely to take up the intervention.
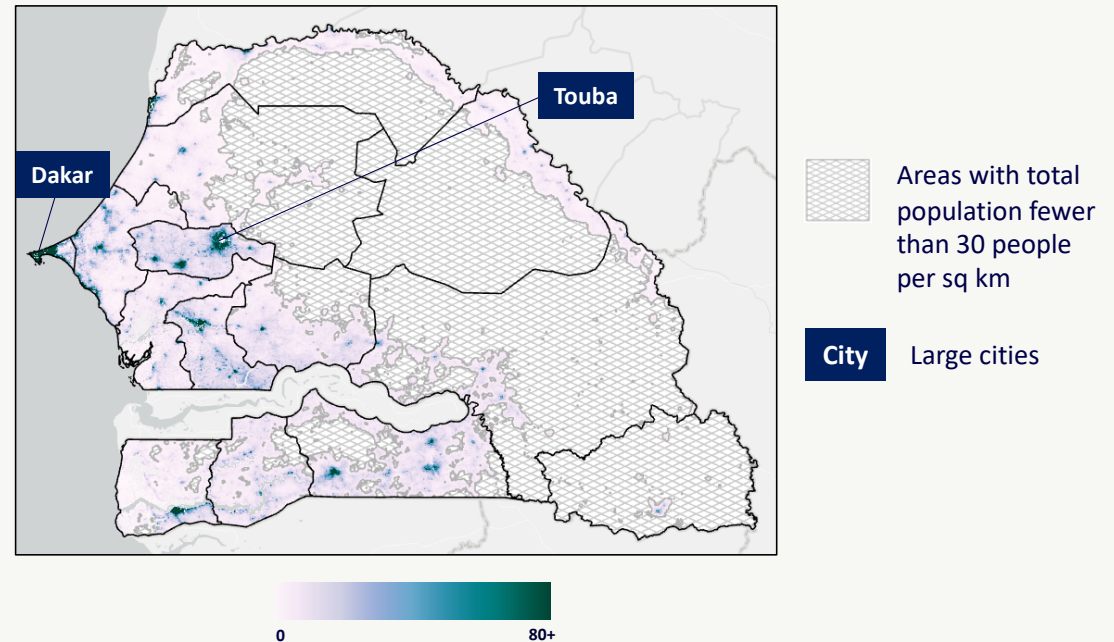

Areas with total population fewer than 30 people per sq km

City — Large cities

0   80+

Intervention Simulation

Target Population	Projected Impact
Initial Rollout	
Urban areas only	26,000 – 73,000 more employed women
Fully Scaled Coverage ('Path to 2030 & Beyond')	
All target beneficiaries	100,000 – 310,000 more employed women

Note 1: Each 1 x 1 square kilometer grid shows baseline female employment of the initial rollout target population. Please see slide 14 for more details. (Source: Fraym, 2019 DHS)

Potential Initial Rollout Sub-Targeting & Benefits

Decisionmakers may also want to consider focusing *initial rollout* in regions with particularly large concentrations of target beneficiaries such as Dakar, Diourbel, Thiès, Kaolack, and Ziguinchor.

Initial Rollout Projected Impact[1]
### Top Five Regions by Target Population
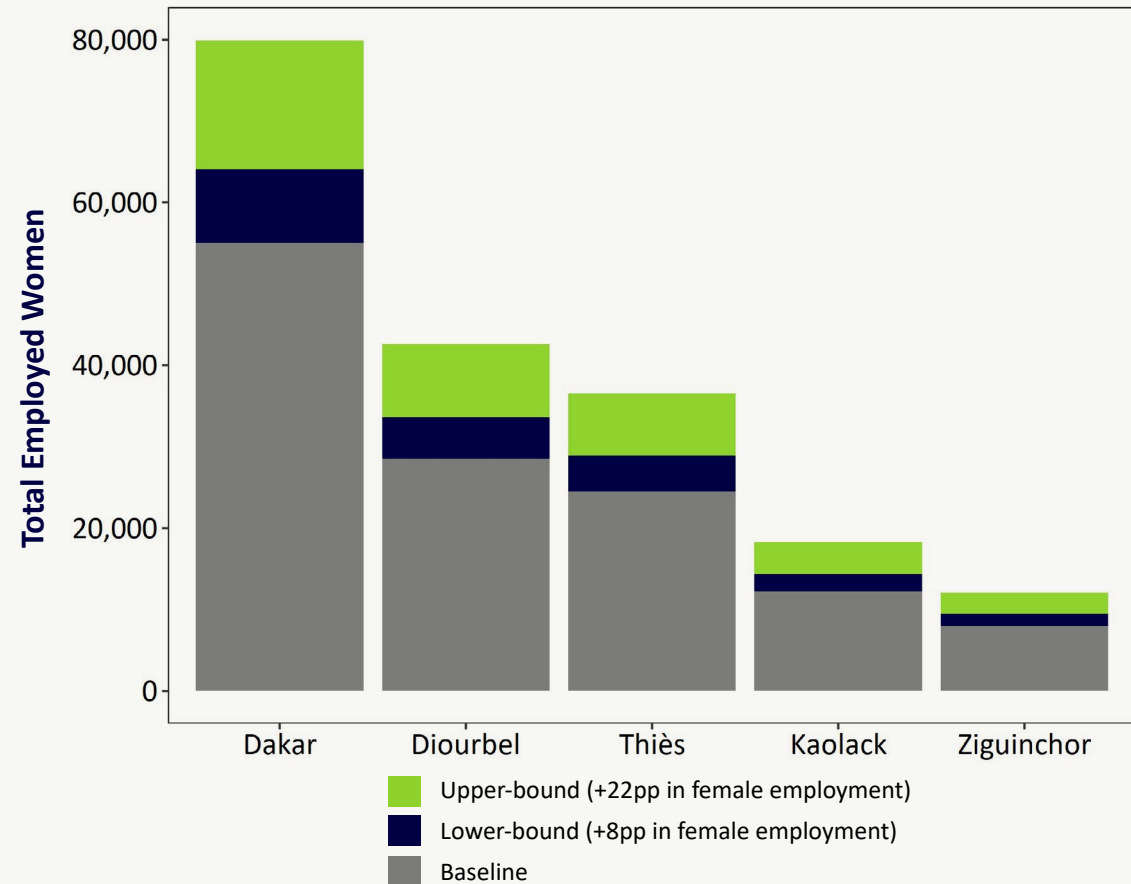
Legend:
- Upper-bound (+22pp in female employment)
- Lower-bound (+8pp in female employment)
- Baseline

Note 1: The height of each bar represents the total number of employed women at baseline, using the lower bound effect size, and using the upper bound effect size. The bars are ordered by initial rollout target population, with Dakar having the largest.

Target Beneficiary Population

In South Africa, 19 percent of all working-aged women and girls (aged 15-49) meet the general eligibility definition and would be potential beneficiaries of a *fully-scaled up* early childcare-based caregiving intervention. Overall, this totals roughly 3.1 million women and girls, with concentrations in and around the three major metro areas (Johannesburg, Cape Town, and Durban).[1]

Percent of working-aged women and girls who are potential candidates for a caregiving intervention[2]

0   100%

Total number of potential candidates for a caregiving intervention[2]

0   200+
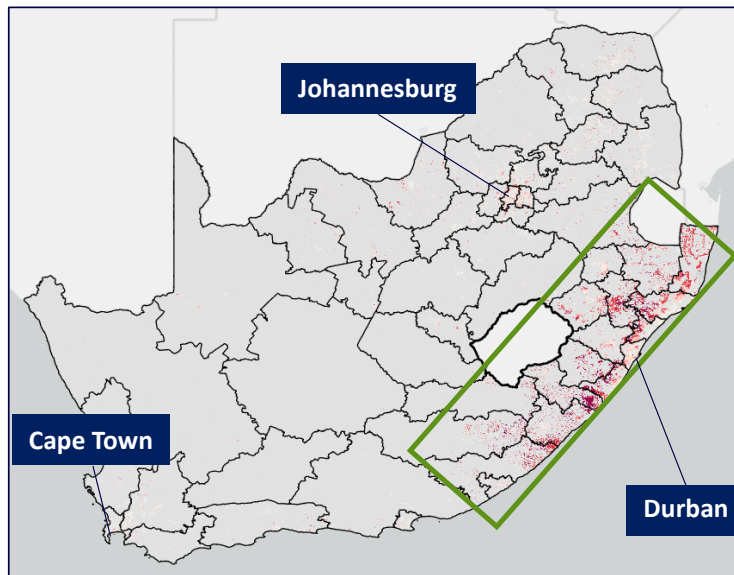
Areas with total population fewer than 30 people per sq km
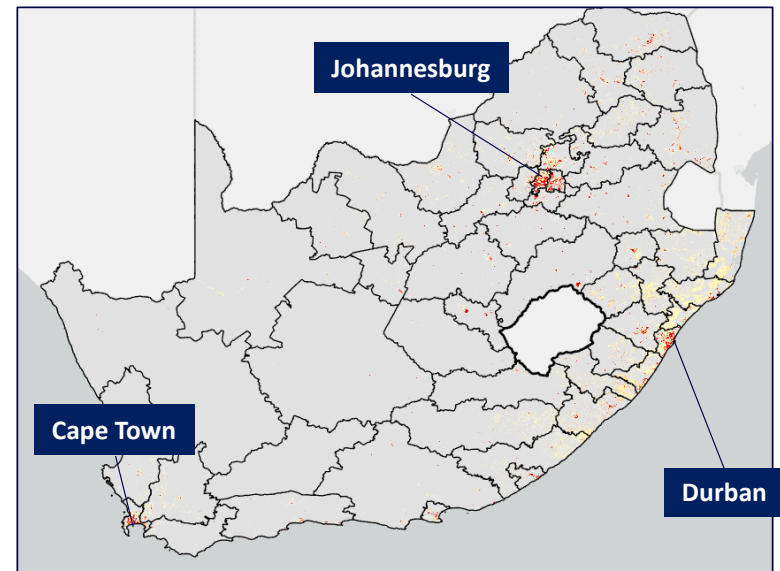
City   Large cities

Note 1: Of this 3.1 million, 2.6 million are located in population dense areas (300+ people per km[2]) where rollout and take up of the program are most likely.
Note 2: Each 1 x 1 square kilometer grid shows the number of potential candidates, or the proportion of people who are potential candidates. Potential candidates are working aged women and girls (15-49) living in poor households (bottom 2 wealth quintiles) with a child 6 years or younger in the household. (Source: Fraym, 2016 DHS)

Estimating Potential Benefits

Based upon similar country program effect ranges, the *initial rollout* of a South African program implemented in *urban areas only* could potentially increase female employment by between 200,000 and 560,000 women.

Baseline (Pre-Intervention)[1]

Roughly 640,000 of the initial rollout target population were already employed during the examined period.

	Areas with total population fewer than 30 people per sq km
City	Large cities

0   90+
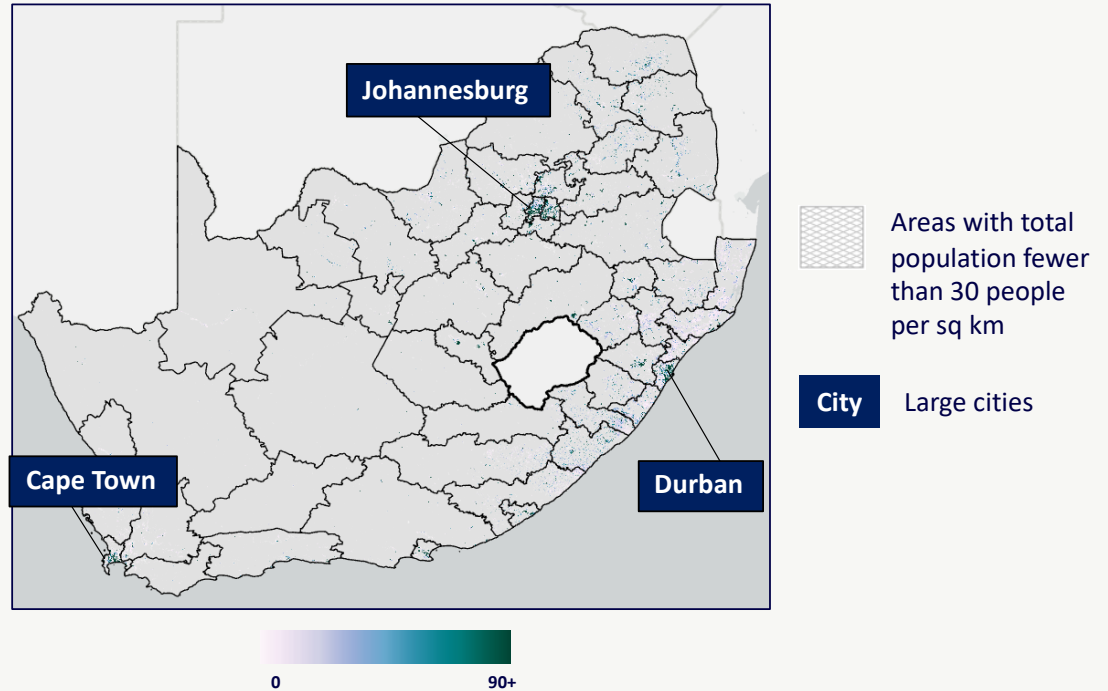
Intervention Simulation

| Target Population	Projected Impact
Initial Rollout	
Urban areas only	200,000 – 560,000 more employed women
Fully Scaled Coverage ('Path to 2030 & Beyond')	
All target beneficiaries	250,000 – 780,000 more employed women

Note 1: Each 1 x 1 square kilometer grid shows baseline female employment of the initial rollout target population. Please see slide 14 for more details. (Source: Fraym, 2016 DHS)

Potential Initial Rollout Sub-Targeting & Benefits

Decisionmakers may also want to consider focusing *initial rollout* in states with particularly large concentrations of target beneficiaries such as Johannesburg, Ekurhuleni, eThekwini, Cape Town, and Tshwane.

Initial Rollout Projected Impact[1]
Top Five Municipalities by Target Population

Note 1: The height of each bar represents the total number of employed women at baseline, using the lower bound effect size, and using the upper bound effect size. The bars are ordered by initial rollout target population, with Johannesburg having the largest.
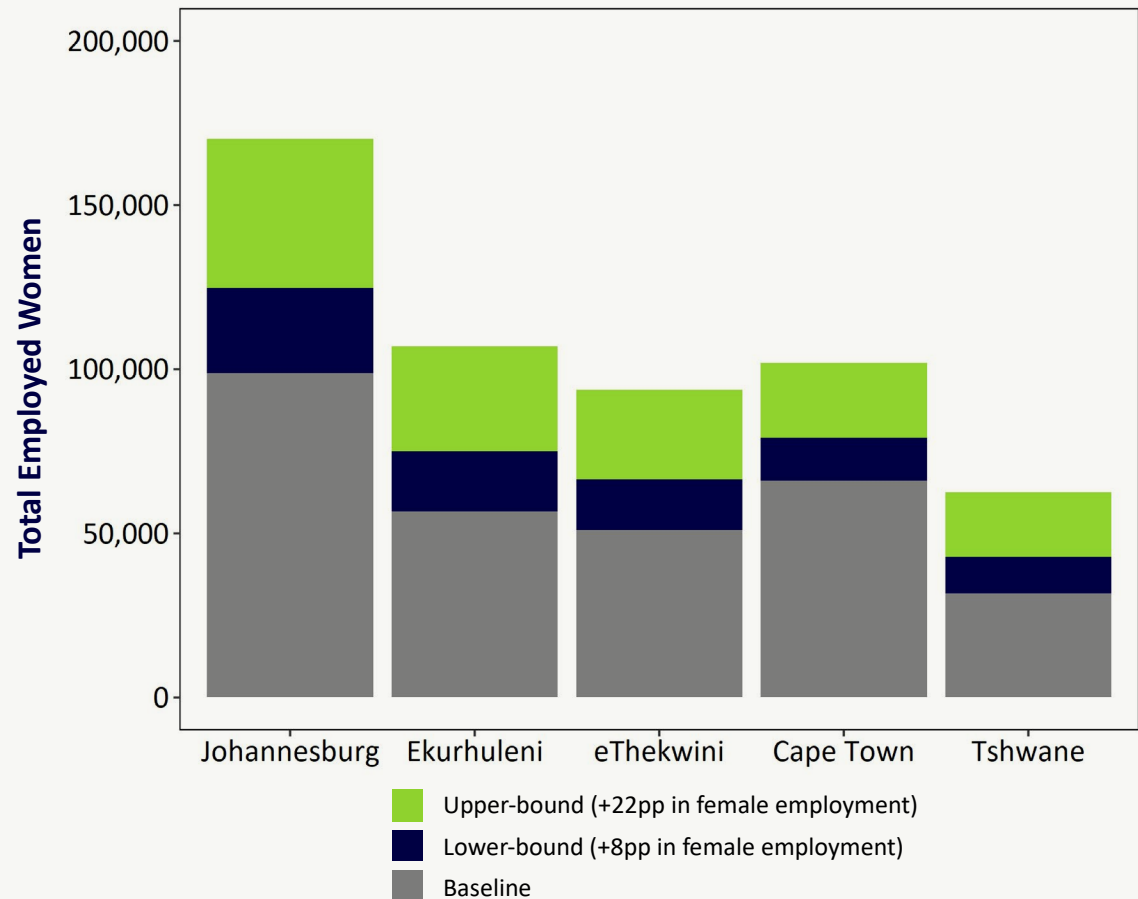
Target Beneficiary Population

In Uganda, 31 percent of all working-aged women and girls (aged 15-49) meet the general eligibility definition and would be potential beneficiaries of a *fully-scaled up* early childcare-based caregiving intervention. Overall, this totals roughly 3 million women and girls, with particularly high concentrations in the Northern and Central Regions.[1]

Percent of working-aged women and girls who are potential candidates for a caregiving intervention[2]
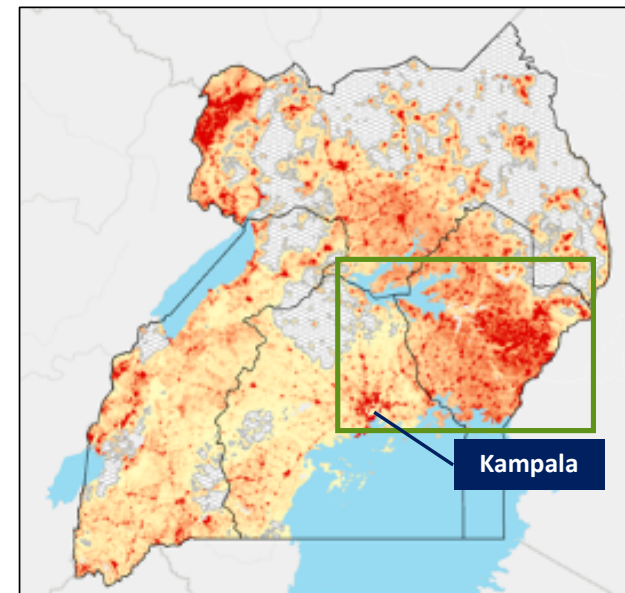

Kampala

0   90%+

Total number of potential candidates for a caregiving intervention[2]

Kampala

0   40+
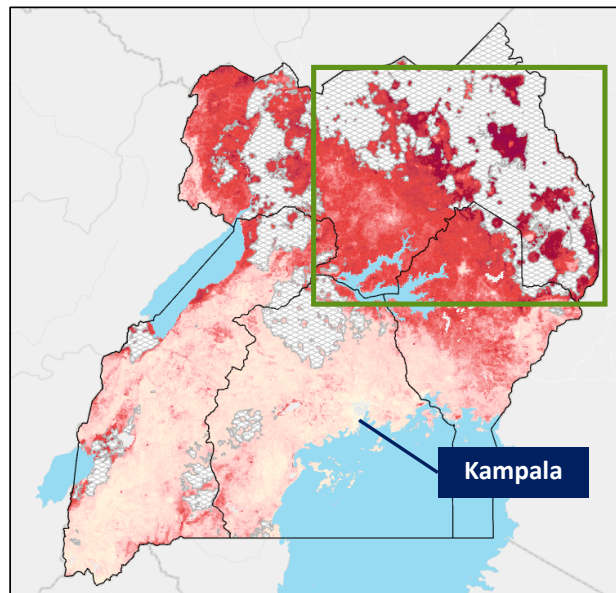
Areas with total population fewer than 30 people per sq km

City   Large cities

Note 1: Of this 3 million, 1.3 million are located in population dense areas (300+ people per km²) where rollout and take up of the program are most likely.
Note 2: Each 1 x 1 square kilometer grid shows the number of potential candidates, or the proportion of people who are potential candidates. Potential candidates are working aged women and girls (15-49) living in poor households (bottom 2 wealth quintiles) with a child 6 years or younger in the household. (Source: Fraym, 2016 DHS)

Estimating Potential Benefits

Based upon similar country program effect ranges, the *initial rollout* of a Ugandan program implemented in *urban areas only* could potentially increase female employment by between 100,000 and 290,000 women.

Baseline (Pre-Intervention)[1]

Roughly 1 million of the initial rollout target population were already employed during the examined period.

Areas with total population fewer than 30 people per sq km

City — Large cities

Kampala

0 — 90+
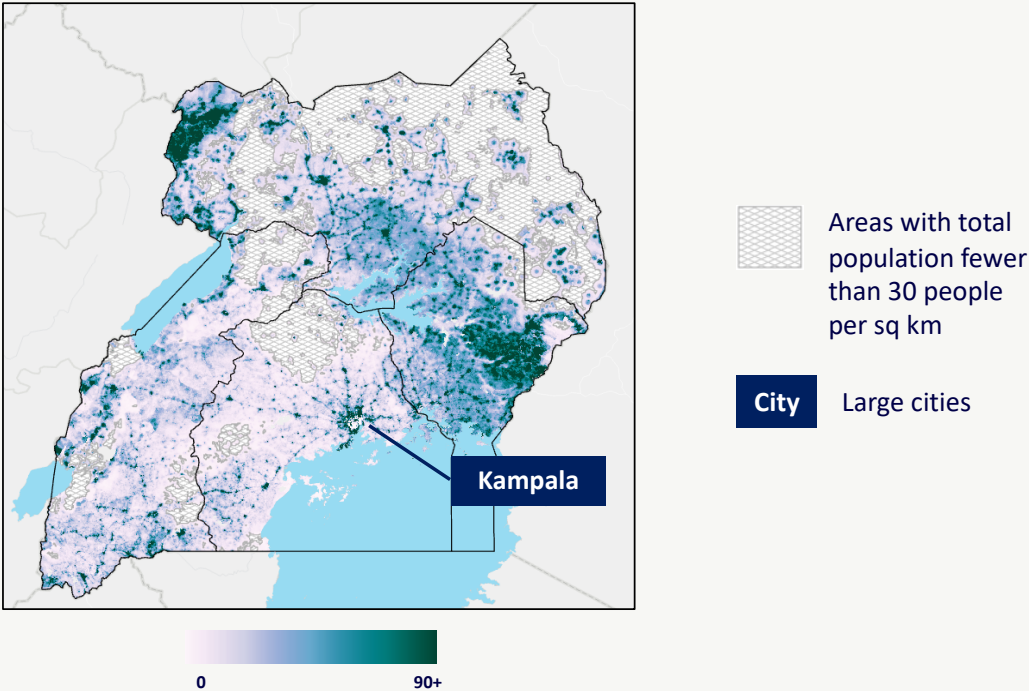
Intervention Simulation

Target Population	Projected Impact
Initial Rollout	
Urban areas only	100,000 – 290,000 more employed women
Fully Scaled Coverage ('Path to 2030 & Beyond')	
All target beneficiaries	250,000 – 770,000 more employed women

Note 1: Each 1 x 1 square kilometer grid shows baseline female employment of the initial rollout target population. Please see slide 14 for more details. (Source: Fraym, 2016 DHS)
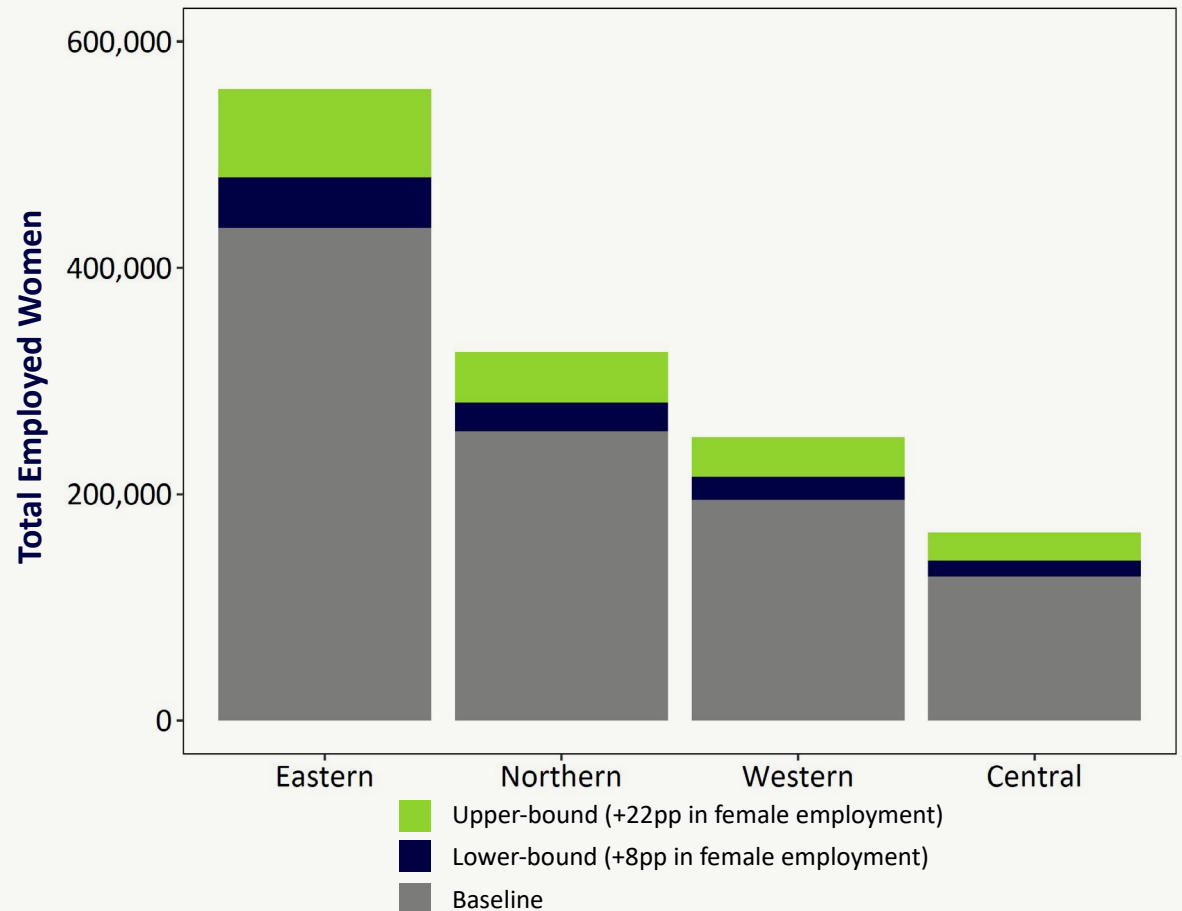
Potential Initial Rollout Sub-Targeting & Benefits

Decisionmakers may also want to consider focusing *initial rollout* in states with particularly large concentrations of target beneficiaries, namely the Eastern region.

Initial Rollout Projected Impact[1]
All Regions of Uganda by Target Population

Total Employed Women (y-axis: 0, 200,000, 400,000, 600,000)

Regions: Eastern, Northern, Western, Central

Legend:
- Upper-bound (+22pp in female employment)
- Lower-bound (+8pp in female employment)
- Baseline

Note 1: The height of each bar represents the total number of employed women at baseline, using the lower bound effect size, and using the upper bound effect size. The bars are ordered by initial rollout target population, with the Eastern region having the largest.

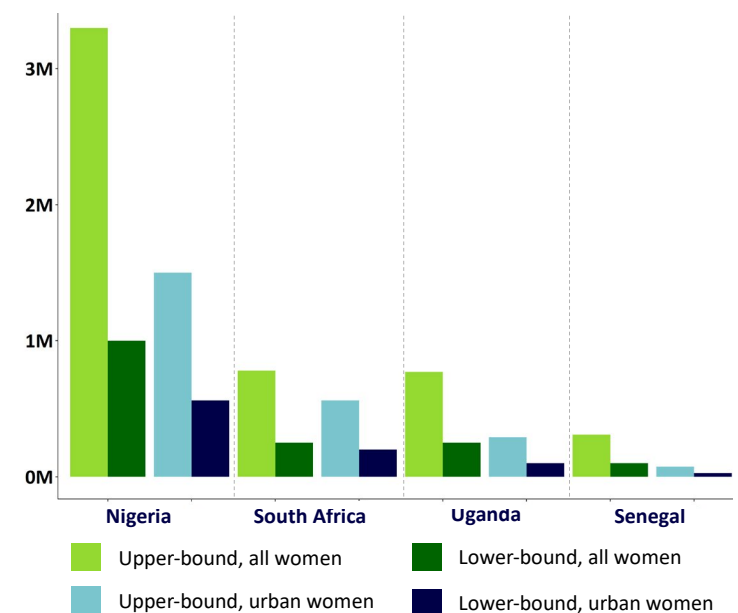# Conclusion

Addressing the Caregiving Crisis

The COVID-19 pandemic is a once-in-a-century crisis. The pandemic has deepened gender inequalities and reinforced gender stereotypes, with women and girls bearing the brunt of care work and disruptions in education and employment. The global community—led by the G7 and G20 and supported by IDA and regional multilateral development banks (MDBs)—has a momentous opportunity to launch a Gender-Transformative Global COVID-19 Recovery Plan.

This report highlights how an ambitious scaling of proven caregiving interventions can support significant improvements in female employment rates. This includes between 890,000 and 2.4 million impacted women in just the four focus countries alone (Nigeria, Senegal, South Africa, and Uganda) through an initial programmatic rollout.

1 An *initial rollout* of a targeted early childcare program could increase female employment by **as many as 2.4 million women** in Nigeria, Senegal, South Africa, and Uganda alone.

2 A *fully scaled-up program* over time could potentially increase employment by **as many as 5.2 million women** in these four countries.

3 The global community has a unique opportunity to financially support a **targeted, efficient, and sequenced rollout** of these types of caregiving support programs.

4 Specifically, the G7 Summit, Generation Equality Forum, G20 Summit, and IDA20 Replenishment present **key political moments for ambitious action**.

Intervention Simulation

Between 890,000– 2.4 million additional women in the target populations could be employed

Legend:
- Upper-bound, all women
- Lower-bound, all women
- Upper-bound, urban women
- Lower-bound, urban women

Appendix

a. Selecting Focus Countries for Impact Simulation

b. References

c. About Fraym

d. Data Sources

Selecting Focus Countries for Impact Simulations

Pre-primary education enrollment rates are high in Kenya, India, and Nigeria, while enrollment is low in Uganda, Senegal, and South Africa. Given these enrollments, Fraym did not simulate the policy in Kenya and India.

Pre-Primary Enrollment by Country
Ages Enrolled Depend on Country Context

Source: Fraym, Nigeria GHS 2019, World Bank 2016-2019 (all other countries)
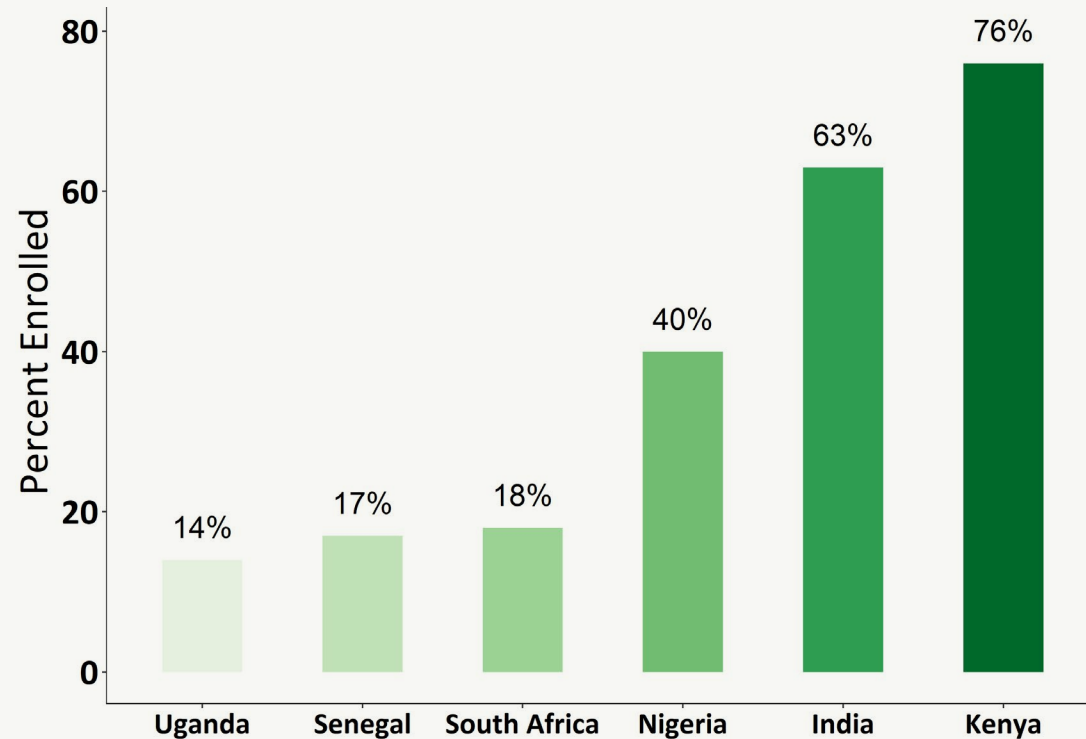
References

Studies used to simulate the selected exemplar intervention (slide 13):

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3   Attanasio, O., de Barro, R. P., Carneiro, P., Evans, D., Lima, L., Olinto, P., & Schady, N. (2017). Impact of free availability of public childcare on labour supply and child development in brazil. *Impact Evaluation Report*, *58*.

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Evans, David K., et al. "The Impact of Early Childhood Interventions on Mothers." *Science*, vol. 372, no. 6544, 2021, pp. 794–796., doi:10.1126/science.abg0132.

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Woetzel, Jonathan, et al. McKinsey Global Institute, 2016, *Delivering the Power of Parity: Toward a More Gender-Equal Society*.

About Fraym

Fraym has built machine learning (ML) software that weaves together geo-tagged household survey data with satellite imagery to create localized population information (1 km^2).

1 The primary ML model input is data from high-quality, geo-tagged household surveys. Key indications of a high-quality household survey include implementing organization(s), sample design, sample size, and response rates. After data collection, *post-hoc* sampling weights are created to account for any oversampling and ensure representativeness.

2 The second major data input is satellite imagery and related derived data products, including earth observation (EO) data, gridded population information (e.g., human settlement mapping, etc.), proximity to physical locations (e.g., health clinics, ports, roads, etc.) and biophysical surfaces like soil characteristics. As with the survey data, Fraym data scientists ensure that the software only uses high-quality imagery and derivative inputs.

3 To create spatial layers from household survey data, Fraym leverages machine learning to predict an indicator of interest at a 1 square kilometer resolution. This methodology builds upon existing, tested methodologies for interpolation of spatial data. The resulting model is used to predict the survey data for all non-enumerated areas. A similar approach was originally developed by academic researchers focused on health outcomes, which were expanded upon by USAID's Demographic and Health Surveys program since then by Fraym and others.[1]

ACQUIRE DATA
Geo-tagged household surveys
Satellite imagery
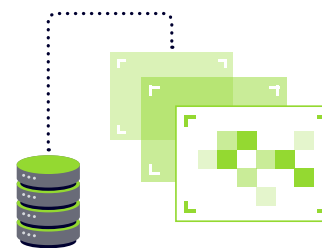Partner datasets
Mobility data from network operators
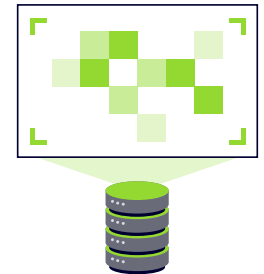
HARMONIZE DATA
Validate
Clean
Geospatially enable

MACHINE LEARNING
Proprietary algorithms
Human-centric QA/QC
Automation

GEOSPATIAL INSIGHT
Predictive modeling
API enabled
Analytic services
Front-end tools

Note 1: Gething, Peter, Andy Tatem, Tom Bird, and Clara R. Burgert-Brucker. 2015. Creating Spatial Interpolation Surfaces with DHS Data DHS Spatial Analysis Reports No. 11. Rockville, Maryland, USA: ICF International. Other notable, relevant work includes: Weiss DJ, Lucas TCD, Nguyen M, et al. Mapping the global prevalence, incidence, and mortality of *Plasmodium falciparum*, 2000–17: a spatial and temporal modelling study. Lancet 2019 and Tatem A, Gething P, Pezzulo C, Weiss D, and Bhatt S. 2014. Final Report: Development of High-Resolution Gridded Poverty Surfaces. University of Southampton. https://www.worldpop.org/resources/docs/pdf/Poverty-mapping-report.pdf

Data Sources

The main microdata sources for this report include the Demographic and Household Surveys and WorldPop.

Fraym used the Demographic and Health Surveys (DHS) as the primary ML model input. These are the latest available geo-tagged surveys for each country.

Additionally, granular population distribution data comes from WorldPop, a publicly available and detailed population distribution and composition data source that leverages existing census data to produce 100m x 100m resolution estimates of population density.

Geo-tagged Household Surveys

Country	Survey
Nigeria	2018 DHS
Senegal	2019 DHS
South Africa	2016 DHS
Uganda	2016 DHS
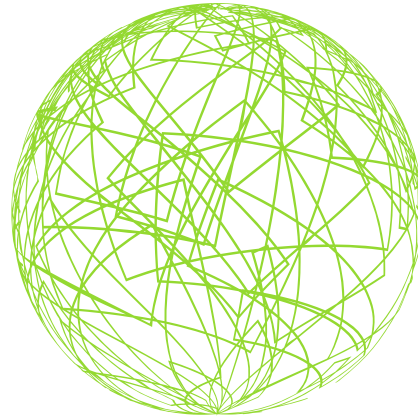
Have questions about how Fraym data can help your organization?
info@fraym.io