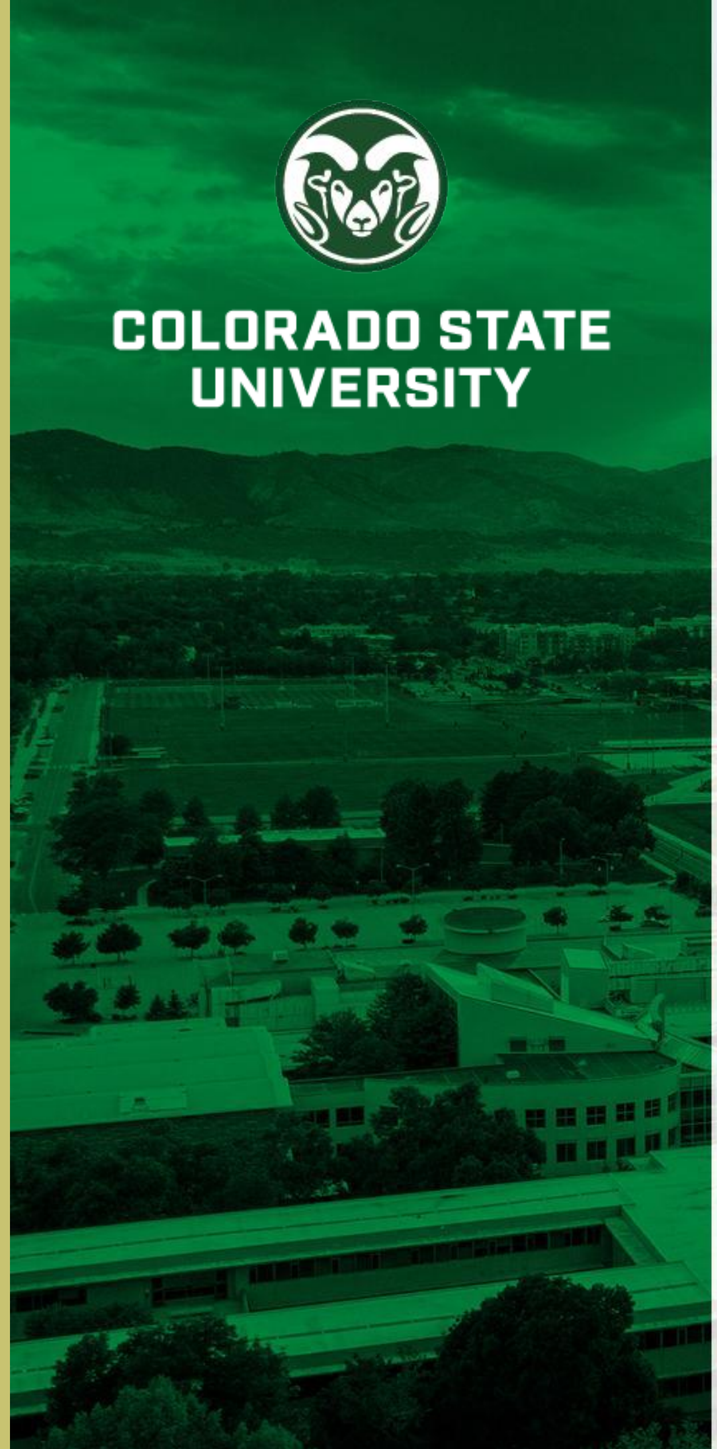

SHEAR:
Whole-House Energy Interventions in Rural Rwanda

Christian L'Orange

SHEAR

Sustainable Household Energy Adoption in Rwanda

COLORADO STATE UNIVERSITY

UNIVERSITY of RWANDA

meshpower rwanda

Maggie Clark, John Volckens, Dale Manning, Vincent Cleveland, Becky Witinok-Huber, Christian L'Orange, Bonnie Young, Ky Tanner, Kellin Slater, Christian Sewor, Cleophas Ahishakiye, John Balmes, Lindsey Zurba, Richard Mori, Casey Quinn, Theoneste Ntakirutimana….and many many more

Study Centered Around Taking a Whole-house Approach

Sources: Individuals are exposed to many sources of air pollution in their homes – meaningful reductions in exposure will require looking beyond any single technology category.

Participants: Response to air pollution depends on more than just exposure - better picture of exposure response requires looking at multiple members of the family.

Decisions: Many factors will impact a households decision making of the energy sources they use – effective and lasting changes to energy usage requires an appreciation of **why** decisions are made.

Tell me what you mean by “clean?”

Knowledge Gaps in HAP's Impact: Despite global recognition, significant knowledge gaps exist regarding the health and climate effects of Household

exposure-re HAP exposure. T with adverse he

Insufficient Evidence for Health Benefits: Health and welfare improvements are claimed as direct benefits of eliminating solid fuel and kerosene co gathered to substant

Critical Ne al question: "How clean is clean enough?" Determining the level of HAP exposure reduction needed for meaningful health benefits among at-risk populations

Central Hy dy proposes a tion to achieve meaningful health-relevant HAP reductions. The goal is to achieve HAP levels below the WHO guideline of 25 µg/m^3 in rural homes,

The Problem: Exposure and health response is complex and something we don’t know very well

The Gap: We have very little understanding of what is “clean enough”

The Hypothesis: Meaningful changes will require addressing the whole house

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Study Overview

- **Approach:** Conduct a randomized controlled trial in rural Rwanda, replacing traditional household energy sources (kerosene and biomass) with solar power and LPG stoves.
- **Participants:** 650 households using traditional energy. Each household has one adult female, one adult male, and one child (aged 8-15 years).
- **Study:** Participants will be followed for 3 years with periodic collection of survey data, exposure measurements, and health measures
  - Blood pressure
  - Lung function
  - Body Mass
  - Dried blood spots (banked for future analysis)

Kerosene lighting

Biomass cooking

Control Arm

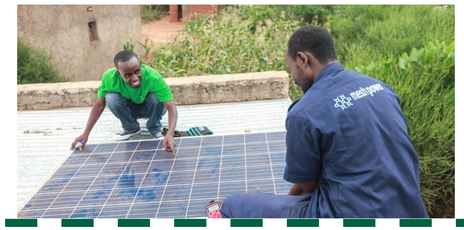
n = 250 households

Liquified Petroleum Gas for cooking

MeshPower LLC – home delivery, mobile pay, stove use monitoring

Solar microgrid for light and power

MeshPower LLC – installation, maintenance, and use monitoring



Treatment Arm

Full subsidy for home energy: LPG + Solar, n = 250 household

Random Subsidy

Monthly energy subsidy varies by household, n = 150 household

What are the health benefits from a fully subsidized intervention to replace traditional household energy with cleaner, more modern forms of energy?

Clinical Trial Intent to Treat Analysis (n = 500)

Exposure-Response Analysis (n = 650)

Cost-Demand Analysis (n = 400)

What is the relationship between HAP exposure and relevant markers of health? How clean is clean enough?

What subsidy will achieve a desired household energy use-rate? What drives usage?

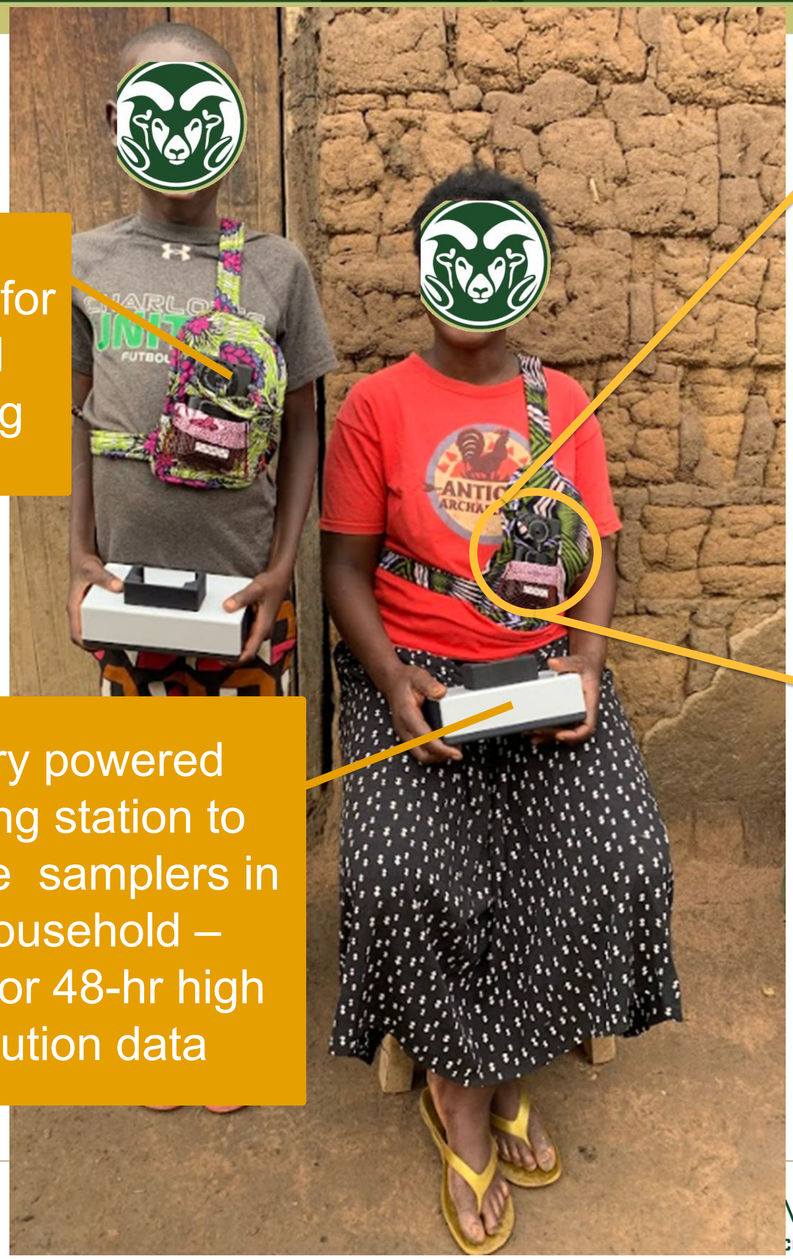
Stove usage using Geocene

Smart meter with credits topped up using cell phone

Two burner LPG stove

Solar based microgrid for lighting and charging of devices

UPAS v2+ for personal monitoring

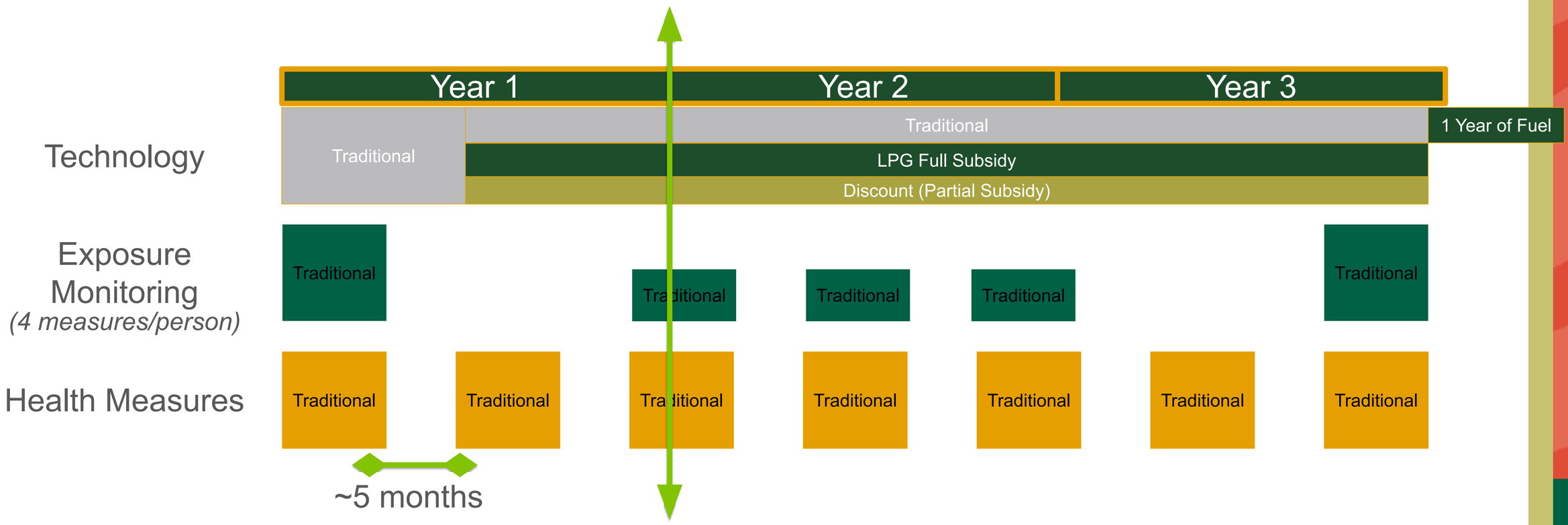


Battery powered charging station to recharge samplers in the household – allows for 48-hr high resolution data

Filter based PM2.5
- Mass
- Black Carbon
- Elemental Composition

Optical Real-Time PM
GPS based location
Accelerometer (movement)
Temperature/RH/Pressure

Study Timeline



Measurement Targets

~3 years of monitoring
~1,660 participants (650 men, women, and children & 15% assumed attrition)
~6,630 personal exposure measurement (15% assumed attrition)
~320,000 hours of exposure monitoring
~600,000 household-days of energy usage monitoring

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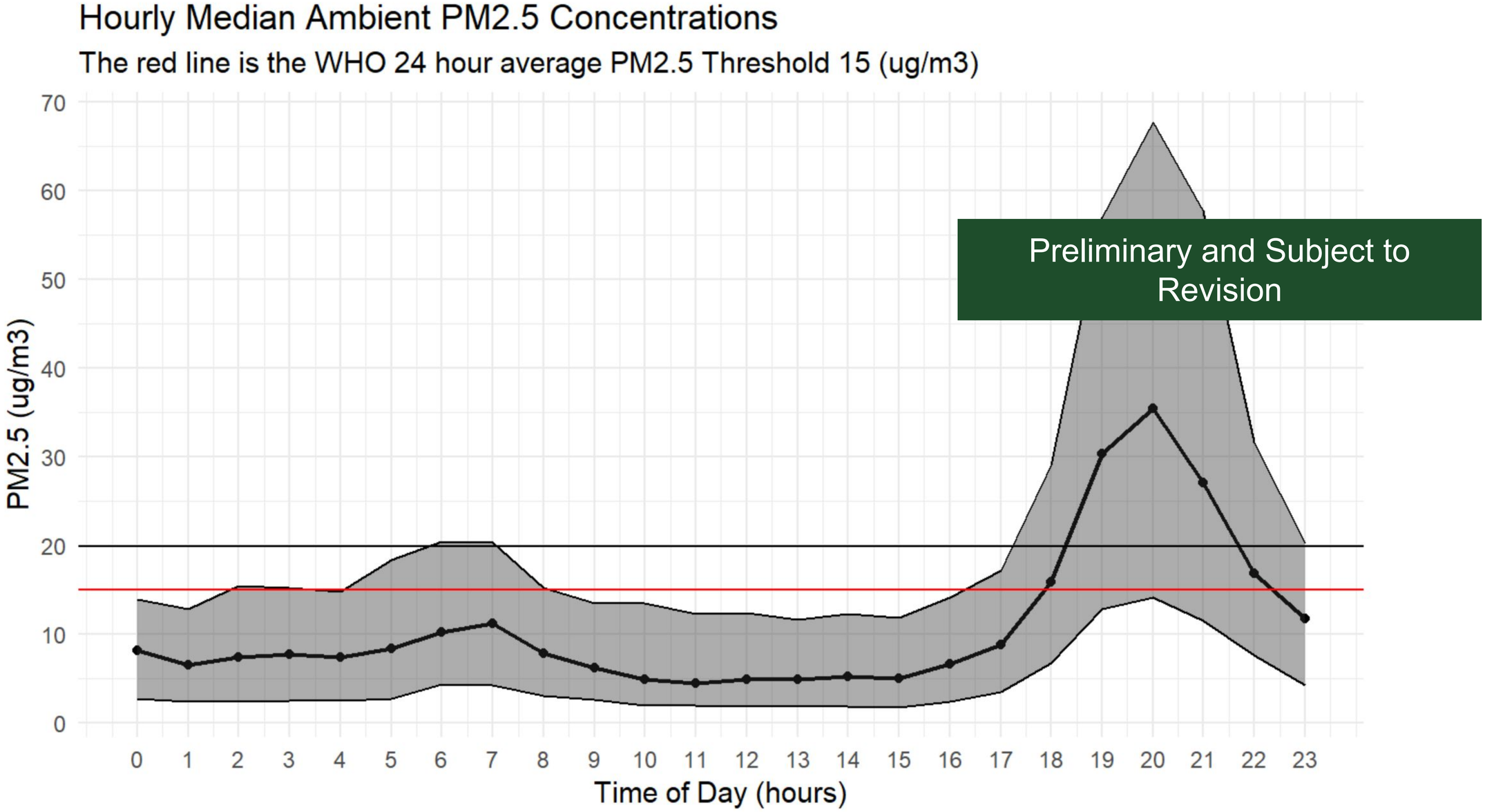
Early Outcomes and Lessons Learned



Working in a rural area is giving us a chance of being able to actually achieve reasonably low exposure

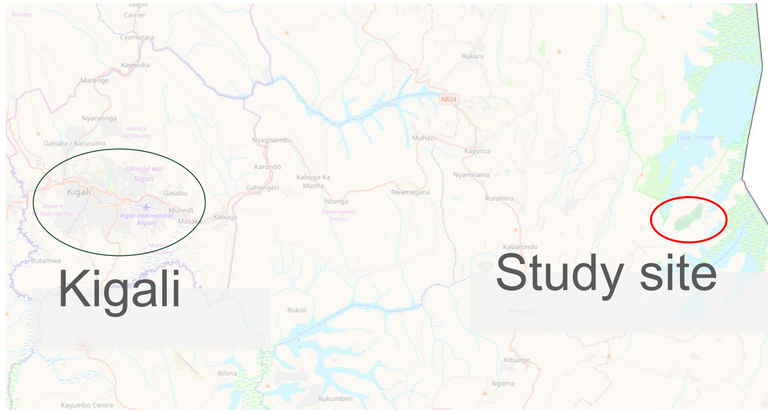
Study Site: Isangano and Karambi Cells in Ndego Sector, Kayonza District, Eastern Province

Dense villages with 2500 households - perfect for gas exchange logistics

2 large mini grids covering 16 villages across 2 cells

Isangano Cell
1200 HH

Karambi Cell
1275 HH



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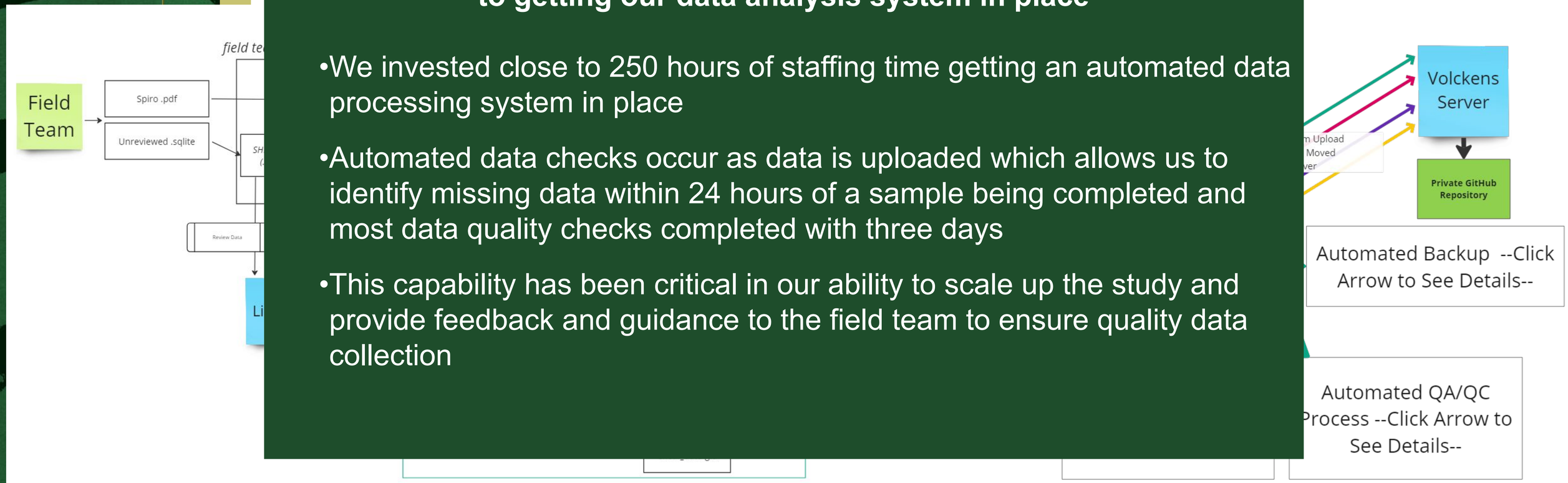
Establishing Data Management Plans Before Starting Data Collection Was

COVID delays allowed for a reallocation of staffing time that was applied to getting our data analysis system in place

- We invested close to 250 hours of staffing time getting an automated data processing system in place
- Automated data checks occur as data is uploaded which allows us to identify missing data within 24 hours of a sample being completed and most data quality checks completed with three days
- This capability has been critical in our ability to scale up the study and provide feedback and guidance to the field team to ensure quality data collection



Discount Arm

Table 1. Values of LPG costs (in RWF/kg) to which participants will be randomized, based on the assumption that the full price of pay-as-you-go LPG is 1600 RWF/kg.

RWF/kg	Discount
1440	90%
1280	80%
1120	70%
960	60%
800	50%
640	40%
480	30%
320	20%