Ghana Team 4S Final Presentation

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June 2012

Ceramic Pot Filter Evaluation, Quality Control/Quality Assurance Program

Matthew Miller

April 27, 2012

Research Objectives

1. Found the best filter composition to date specific to the factory in Tamale, Ghana

2. Identified quality control measures
   - Simple
   - Low-cost
   - Indicate ceramic pot filter effectiveness in removing harmful pathogens, as is specified by total coliform removal

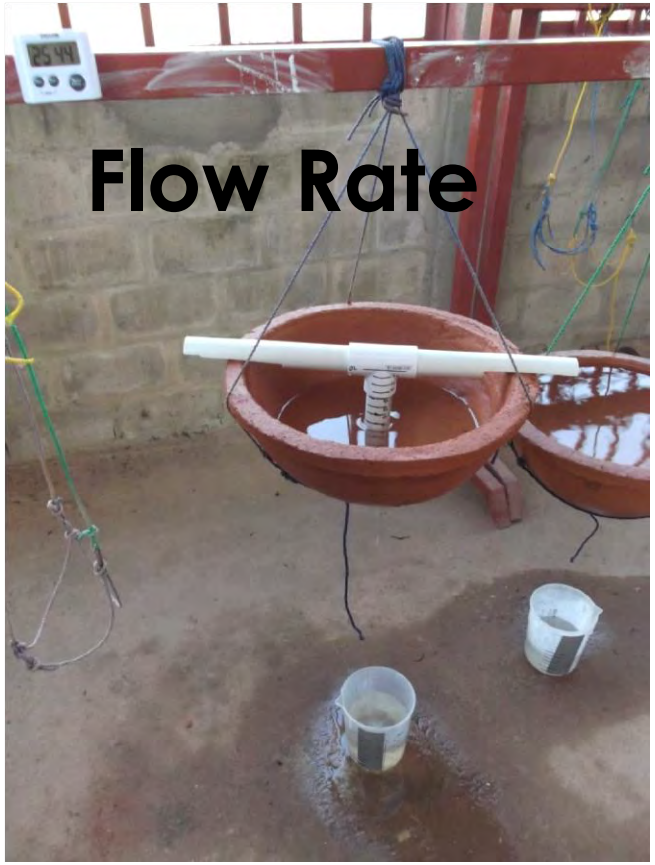
3. Developed a Quality Assurance Program specific to Pure Home Water

Results Outline

- Objective #1
  - Performance Criteria #1
  - Performance Criteria #2
  - Performance Criteria #3
- Objective #2
  - QC Measure #1
  - QC Measure #2
  - QC Measure #3

Objective #1: Best Filter Composition

- Three Performance Criteria:

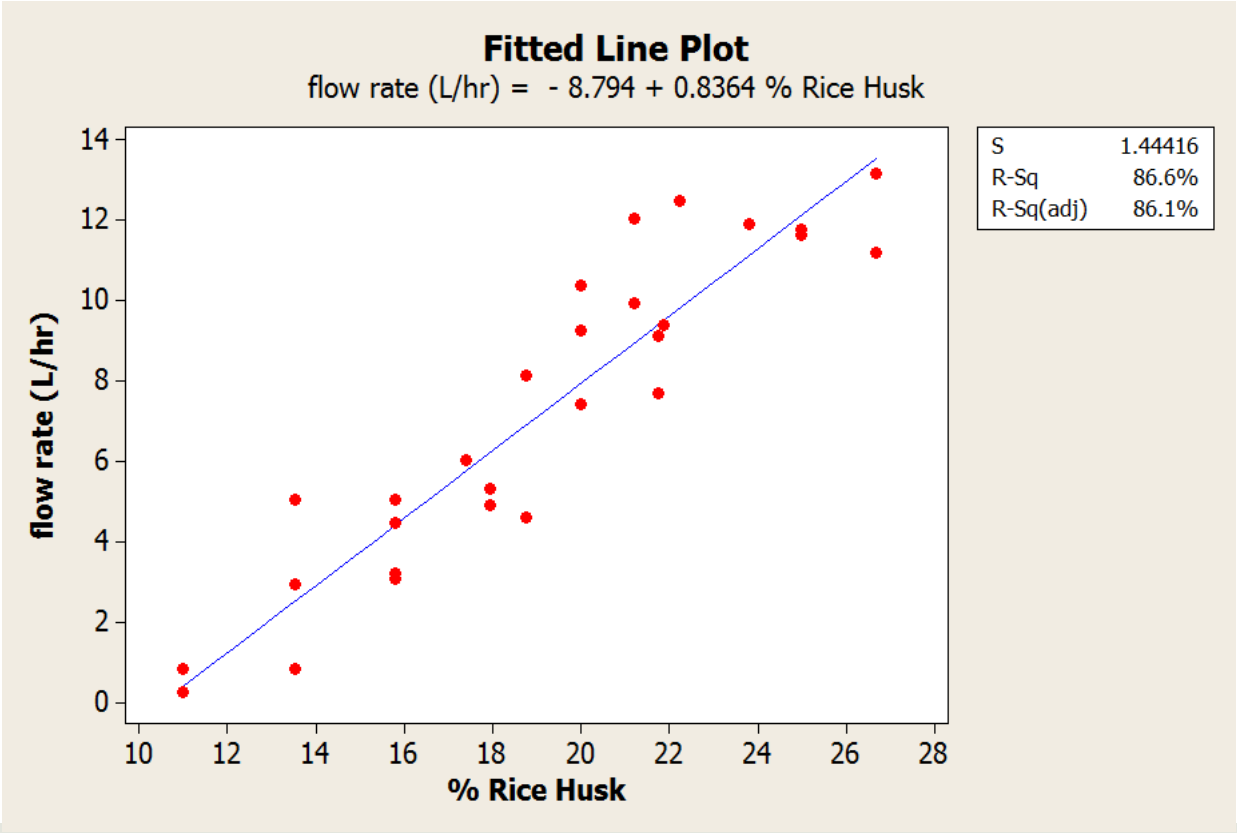


Performance Criteria #1: Bacteria Removal

- Out of 9 Production Variables tested, none seemed to affect bacteria removal

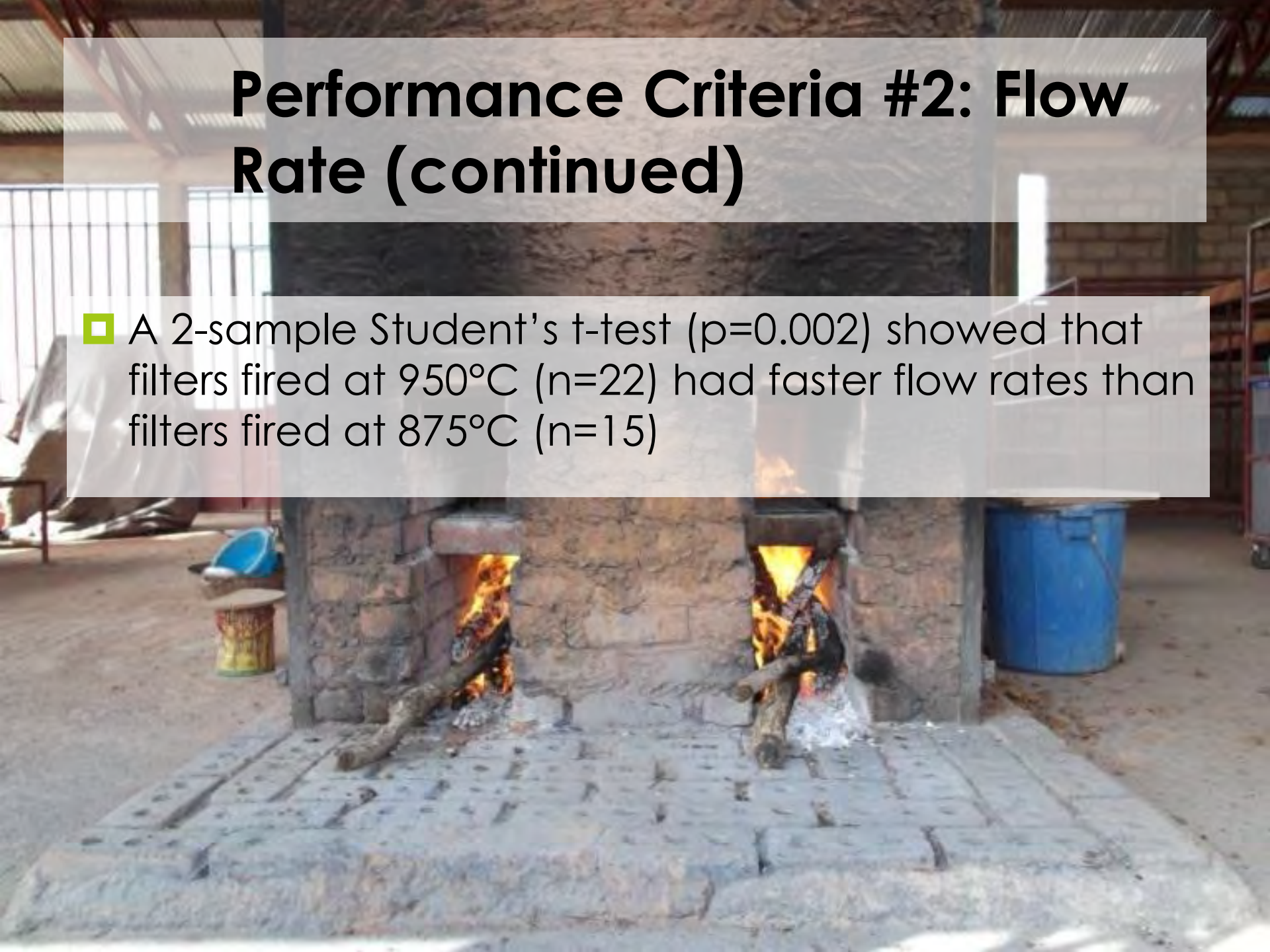
Performance Criteria #2: Flow Rate

- Regression showed that as percent rice husk increases, flow rate increases (n=31)



Performance Criteria #2: Flow Rate (continued)

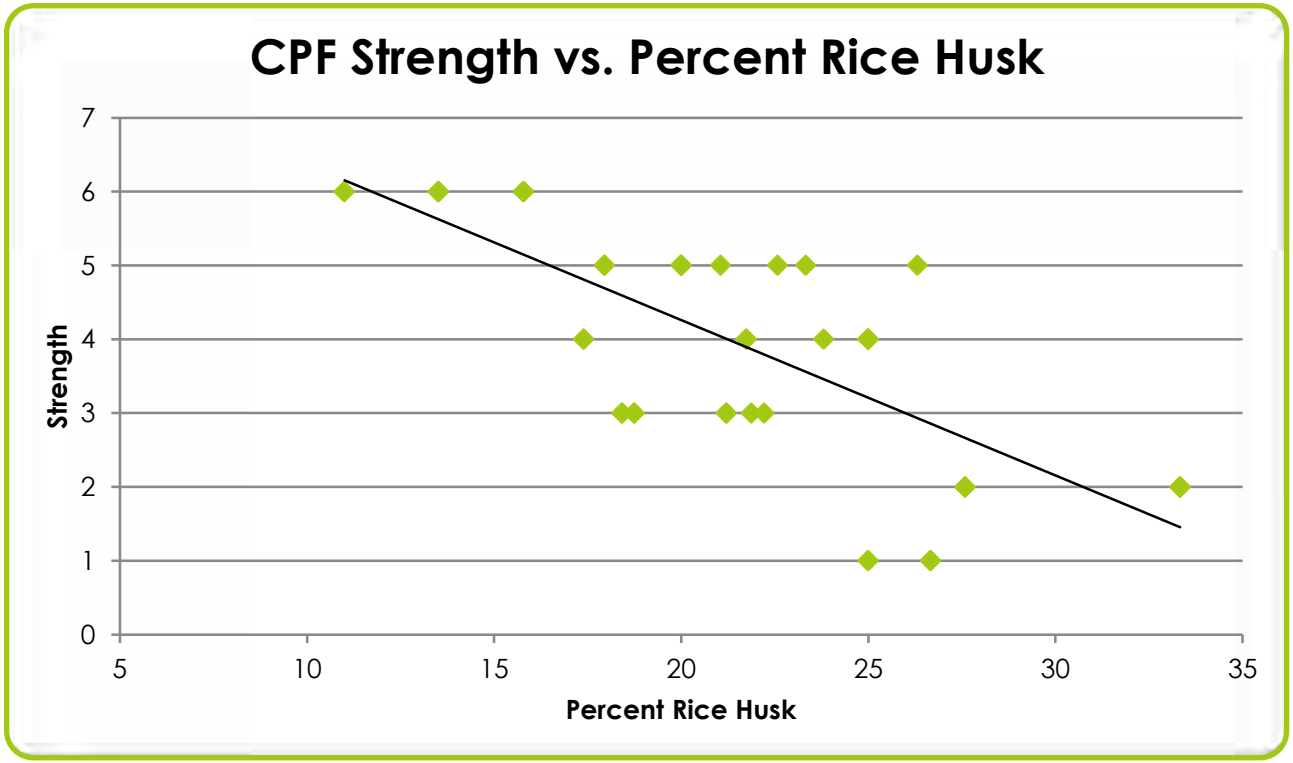
- A 2-sample Student's t-test ($p=0.002$) showed that filters fired at 950°C ($n=22$) had faster flow rates than filters fired at 875°C ($n=15$)



Performance Criteria #3: Strength

- Ordinal logistic regression showed that as percentage of rice husk used increases, filter strength decreases (n=31)
- 6 qualitative predictor variables:

6-very strong
5-strong
4-moderate
3-fair
2-weak
1-very weak



Objective #2: Quality Control (QC) Measures

- 6 tests failed
  - turbidity
  - turbidity tube
  - porosity
  - percent absorption
  - flow rate
  - filter's dry mass
- 3 tests confirmed as quality control measures
  - Bubble Test
  - First Drip Test
  - Tortuosity Representation

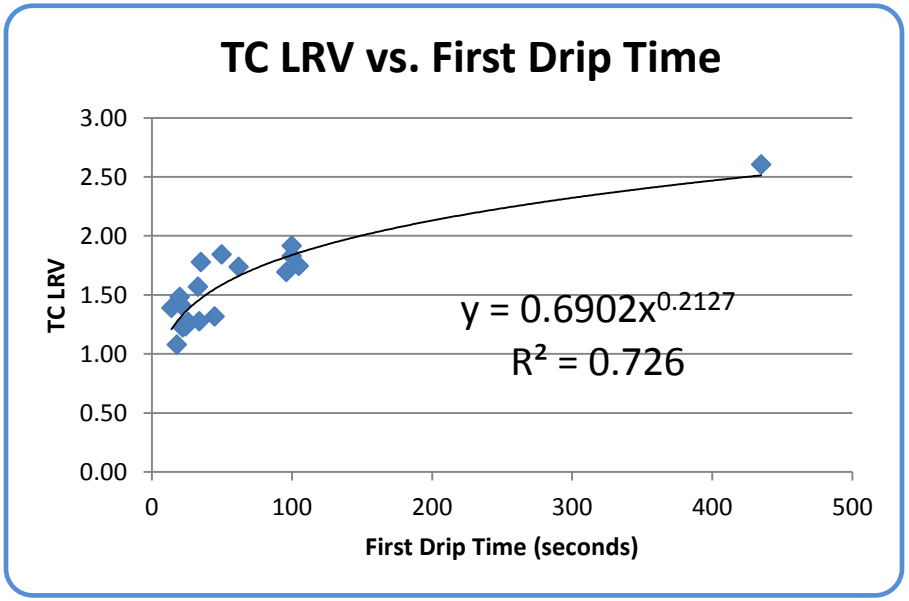
QC Measure #1: Bubble Test

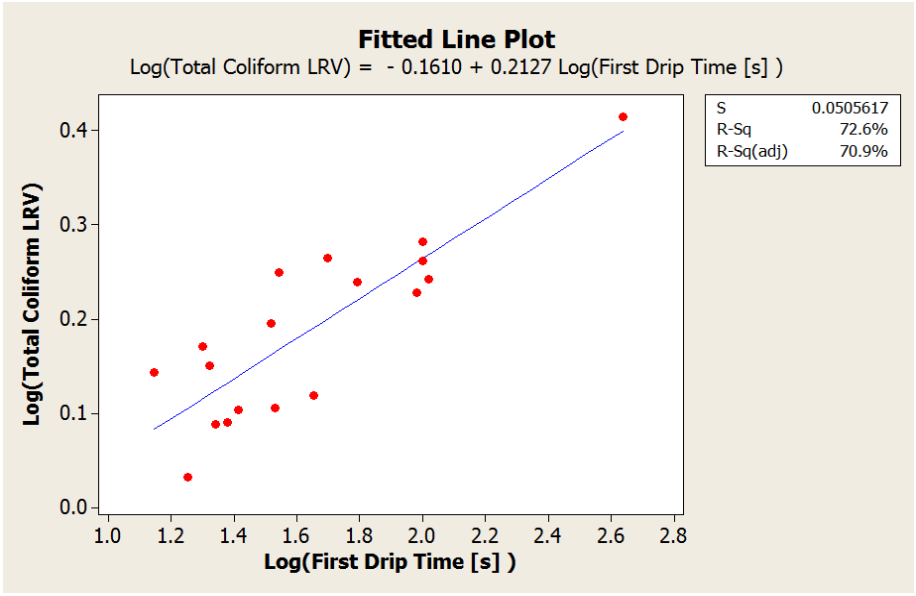
- A 2-sample Student's t-test ($p=0.003$) showed that the total coliform (TC) removal for filters that passed the bubble test ($n=50$) have a higher total coliform bacteria removal than did filters that failed the bubble test ($n=14$)

Kleiman (2011)

QC Measure #2: First Drip Test

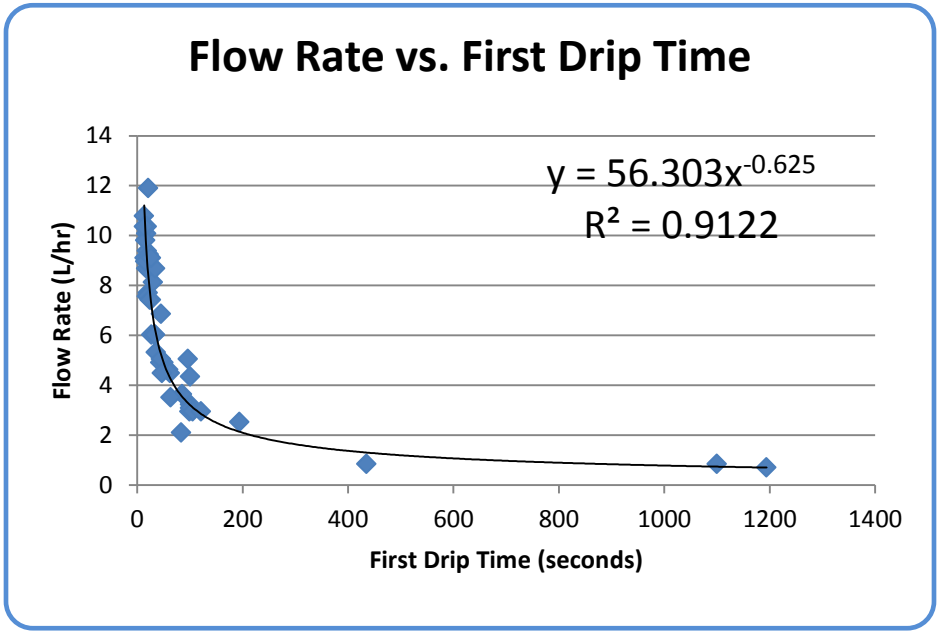
- $TC\ Log\ Removal\ Value = 0.6902 \times First\ Drip\ Time^{0.2127}$
- As time to first drip increases, total coliform removal increases according to a power curve (n=18)

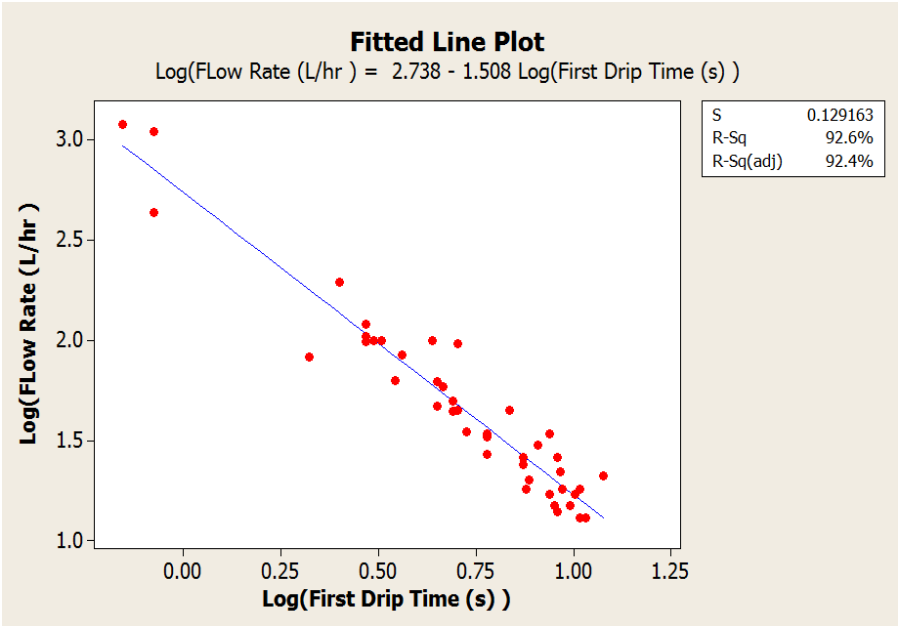




QC Measure #2: First Drip Test (continued)

- $Flow\ Rate = 56.303 \times First\ Drip\ Time^{-0.625}$
- As time to first drip increases, flow rate decreases (n=42) according to the Young-Laplace equation for capillary pressure: $\Delta p = \frac{2\gamma cos\theta}{a}$





QC Measure #3: Tortuosity Representation

- Through multiple regression (n=18) it was found that the combination of three factors which play a role in tortuosity can explain 85.2% of the variance in total coliform removal

- Total Coliform LRV = - 0.058 - 0.110*[Flow Rate (L/hr)] + 5.53*Porosity + 0.00197*[First Drip Time (s)]

Recommendations

1. How the distribution of the rice husk particle sizes affects total coliform removal

2. How the total coliform removal and flow rate are affected over long term consistent use

3. How kiln variables (max temp, firing duration, and soak time) affect total coliform removal

Monitoring & Evaluation of a ceramic water filter and hand-washing intervention

Connie Lu | Ghana 4S | April 27, 2012

Why monitor water treatment & hygiene interventions?

- Health impact:
  - Reduce incidence of diarrhea:
    - 30-40% Point of use water treatment (Clasen *et al.*, 2007)
    - 42-44% Hand washing with soap (Curtis and Cairncross 2003)
  - Reduce incidence of acute respiratory illnesses:
    - 24% Hand washing with soap (Rabie and Curtis 2006)

Photos courtesy of Adam Questad, and http://www.thecorrectness.com/

Why monitor water treatment & hygiene interventions?

- Health impact:
  - Reduce incidence of diarrhea:
    - 30-40%
    - 42-44%
  - Reduce incidence of acute respiratory illnesses:
    - 24%

Point of use water treatment (Clasen *et al.*, 2007)

Hand washing with soap (Curtis and Cairncross 2003)

Hand washing with soap (Rabie and Curtis 2006)

Only if used correctly & consistently!

User adoption & sustained use often low.

46% (Clopeck, 2009)

Photos courtesy of Adam Questad, and http://www.thecoolnetpress.com/

Photo courtesy of Susan Murcott

Monitoring opportunity: Sales of ceramic water filters and hand washing stations to 1250 households in summer 2012

Evaluating PHW-Rotary project: Objective

- To evaluate the **user adoption**, **sustained use** and **health impact**

Photo courtesy of Susan Murcott

Evaluating PHW-Rotary project: Objective

- To evaluate the **user adoption**, **sustained use** and **health impact** of ceramic water filters and hand washing materials to be distributed by PHW in Summer 2012

Photo courtesy of Susan Murcott

1_Design evaluation framework:

- Selected method: Longitudinal study
  - Repeated observations of the same variables over a long period of time.
  - **Study participants**: Peri-urban households in Tamale region
  - **Factor/Exposure**: Use of ceramic water filters; Use of handwashing stations
  - **Outcome/Disease**: Diarrheal and respiratory illness

Photo courtesy of Wikipedia Commons

1_Design evaluation framework

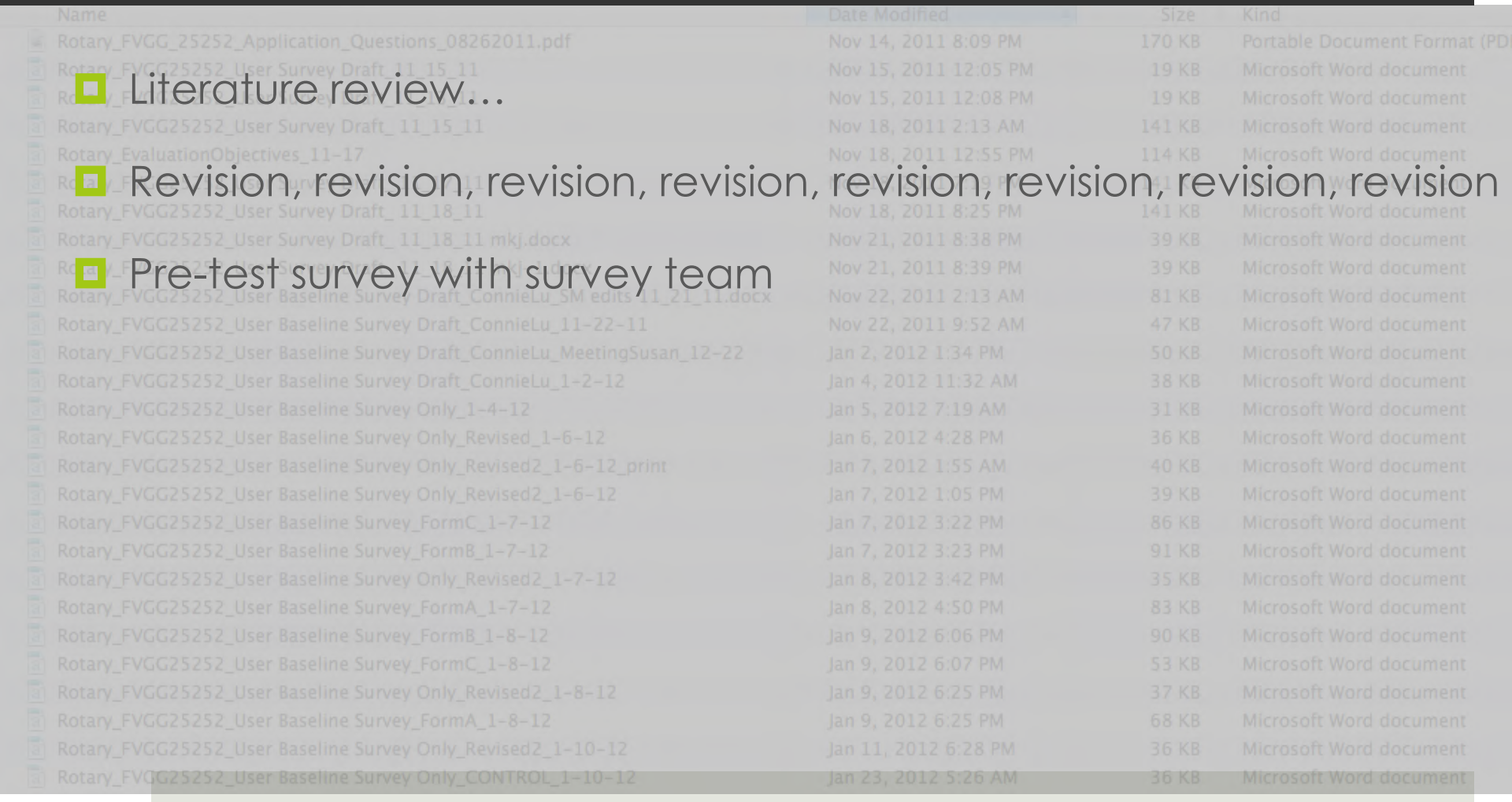
- Baseline survey
- 1-month follow-up survey (Measure tech adoption only)
- 4- to 6-month follow-up survey

1_Design evaluation framework

- Baseline survey
- 1-month follow-up survey (Measure tech adoption only)
- 4- to 6-month follow-up survey

2_Write baseline survey

- Literature review…
- Revision, revision, revision, revision, revision, revision, revision, revision
- Pre-test survey with survey team



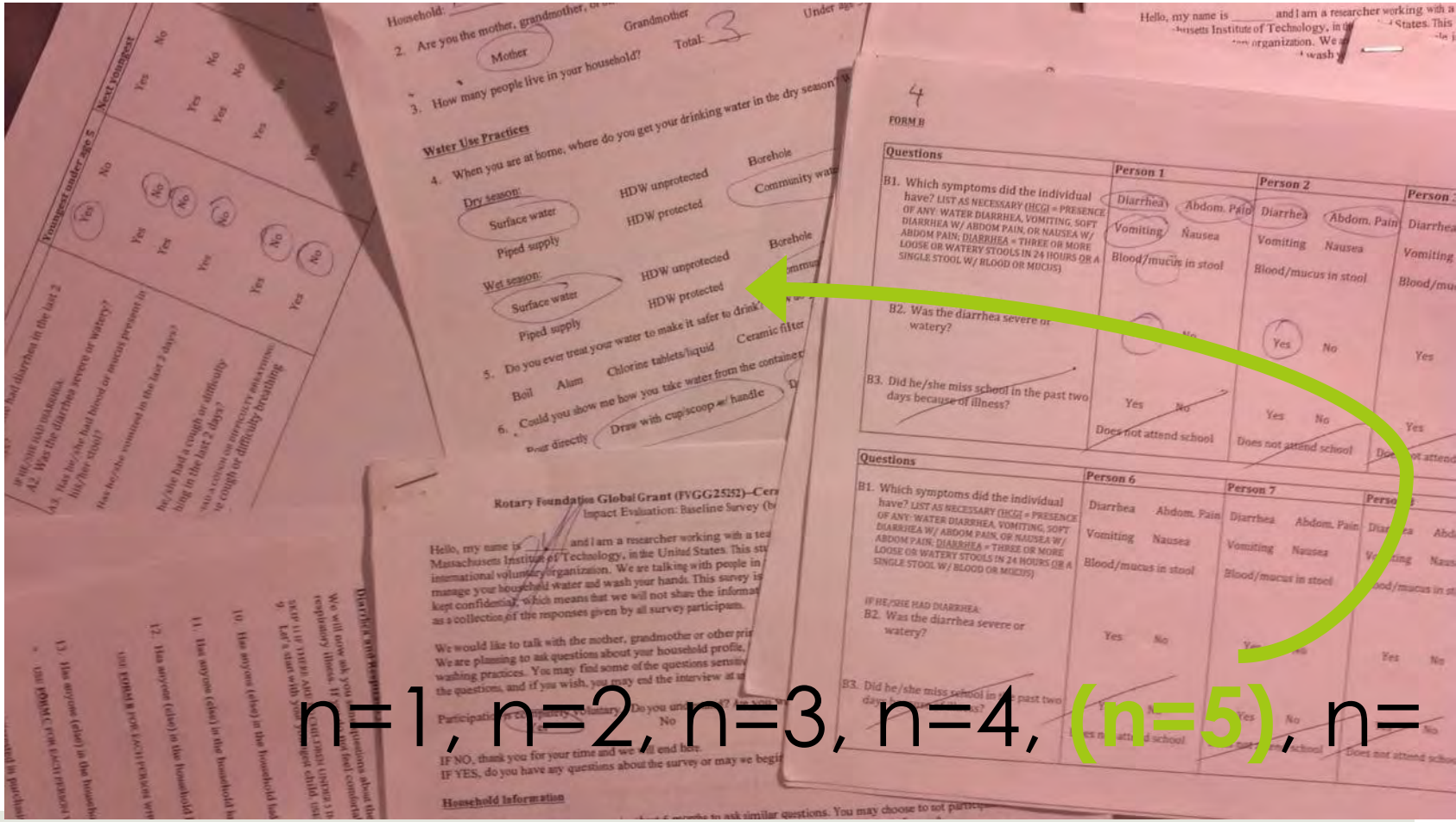
3_Conduct baseline survey

Photo courtesy of Winnie Qiu

(Dream team) Zainab & Emelia

3_Conduct baseline survey

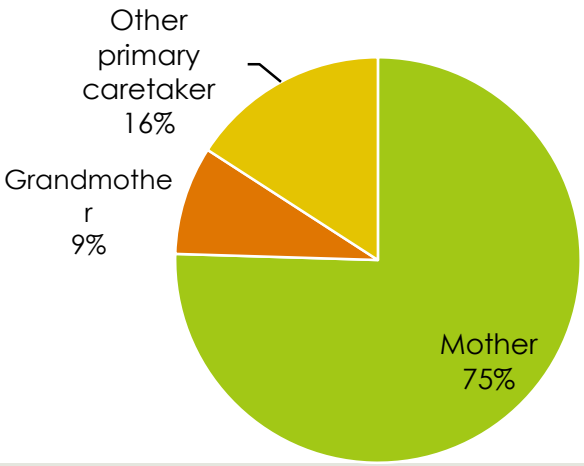
4_Digitize and analyze



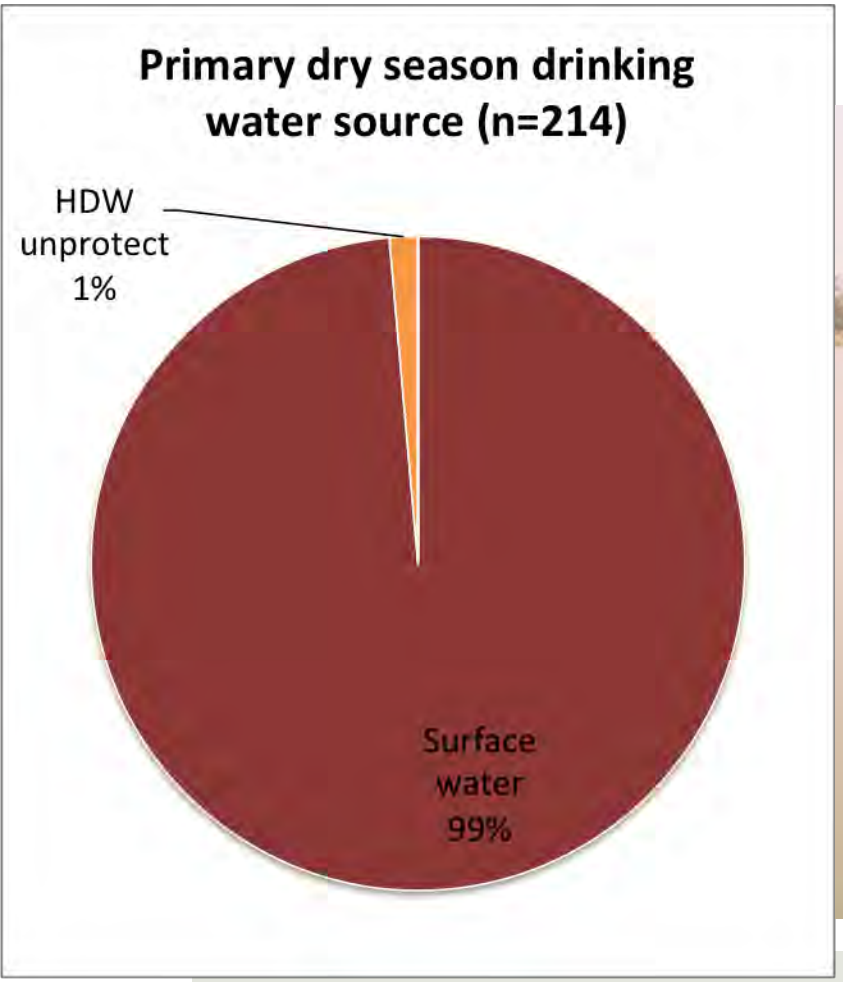
Household information

- 214 households interviewed
- 8.0 individuals per household, on average
- 1.6 children under age 5 per household, on average

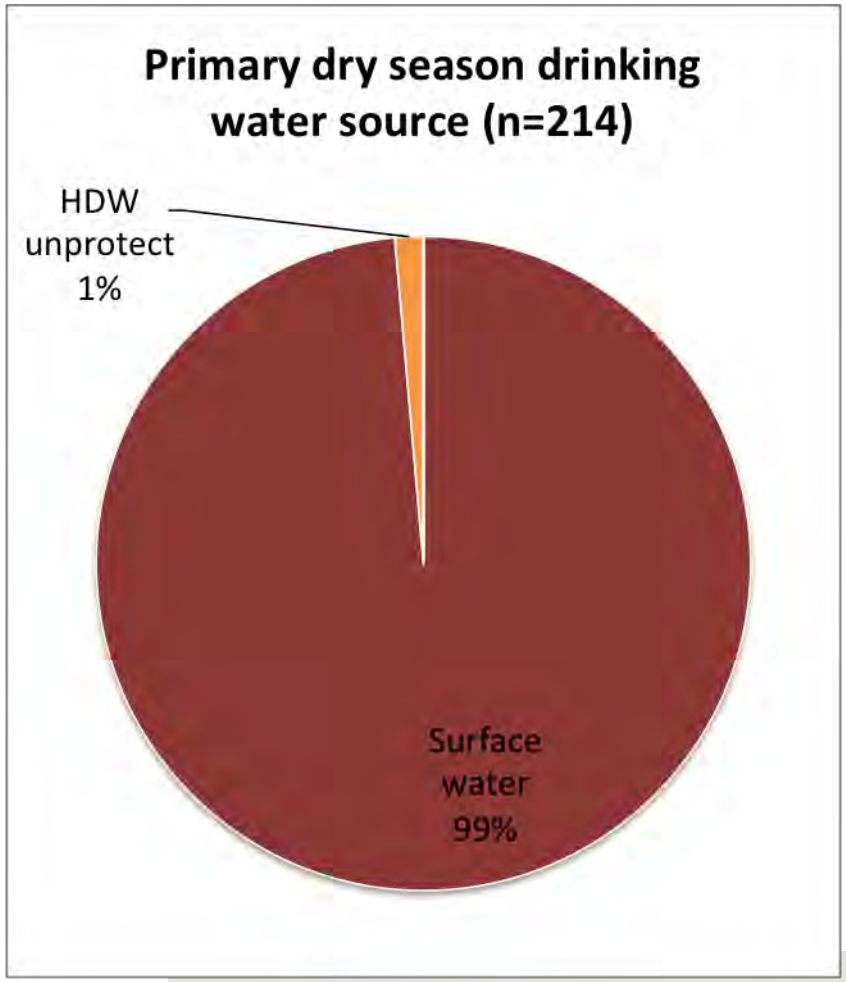
Household respondent (n=208)

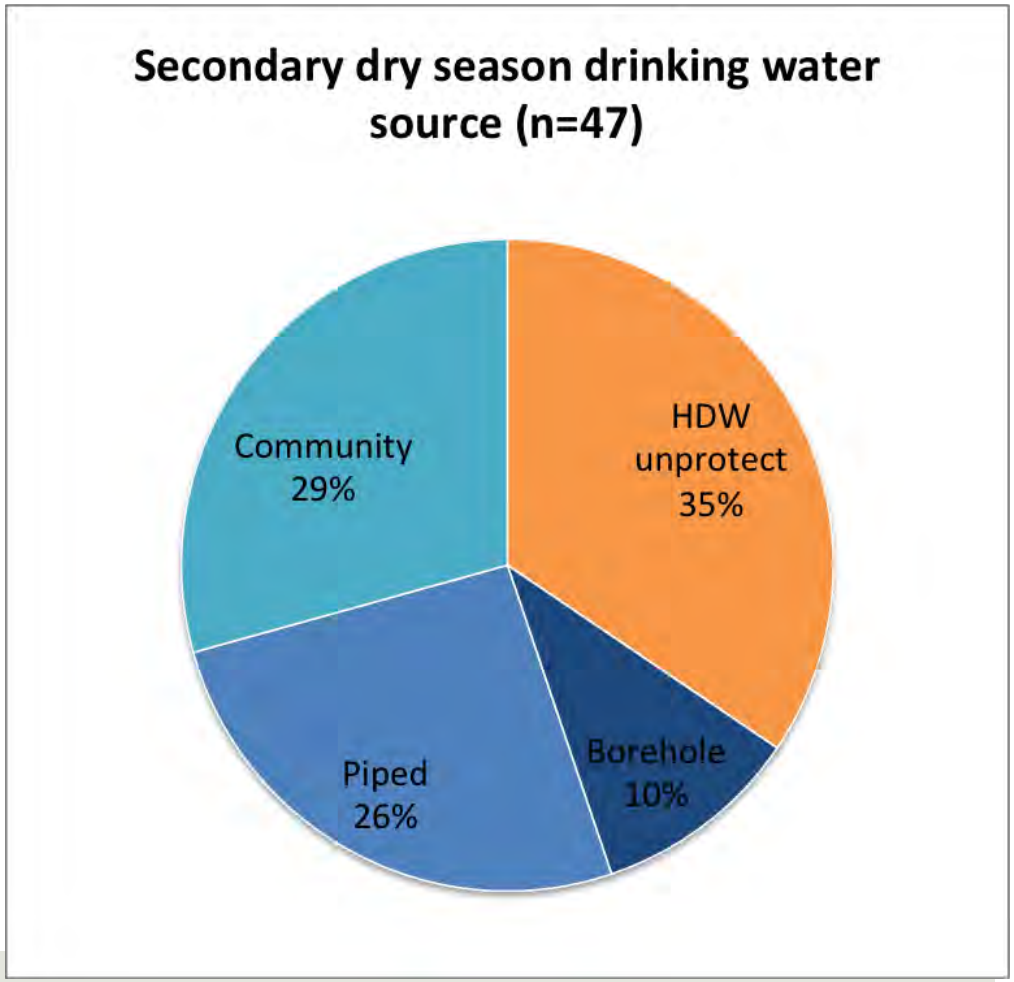


Drinking water sources: Dry season



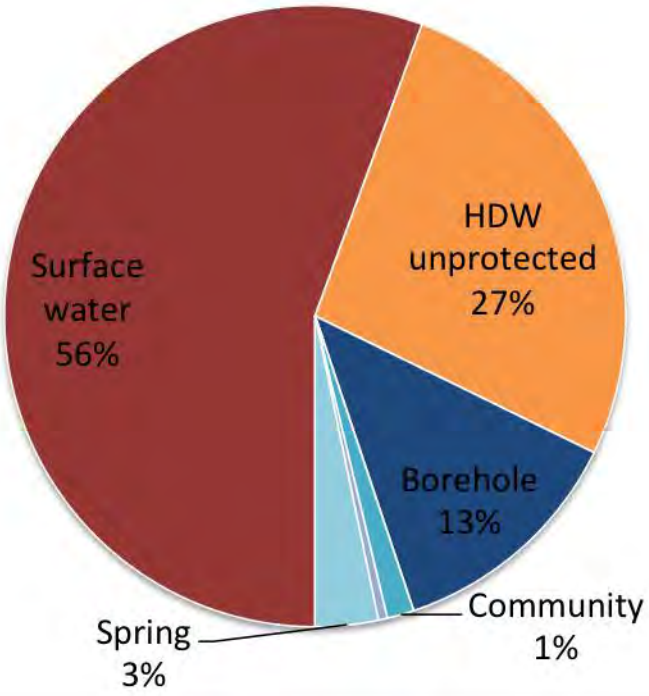
Drinking water sources: Dry season



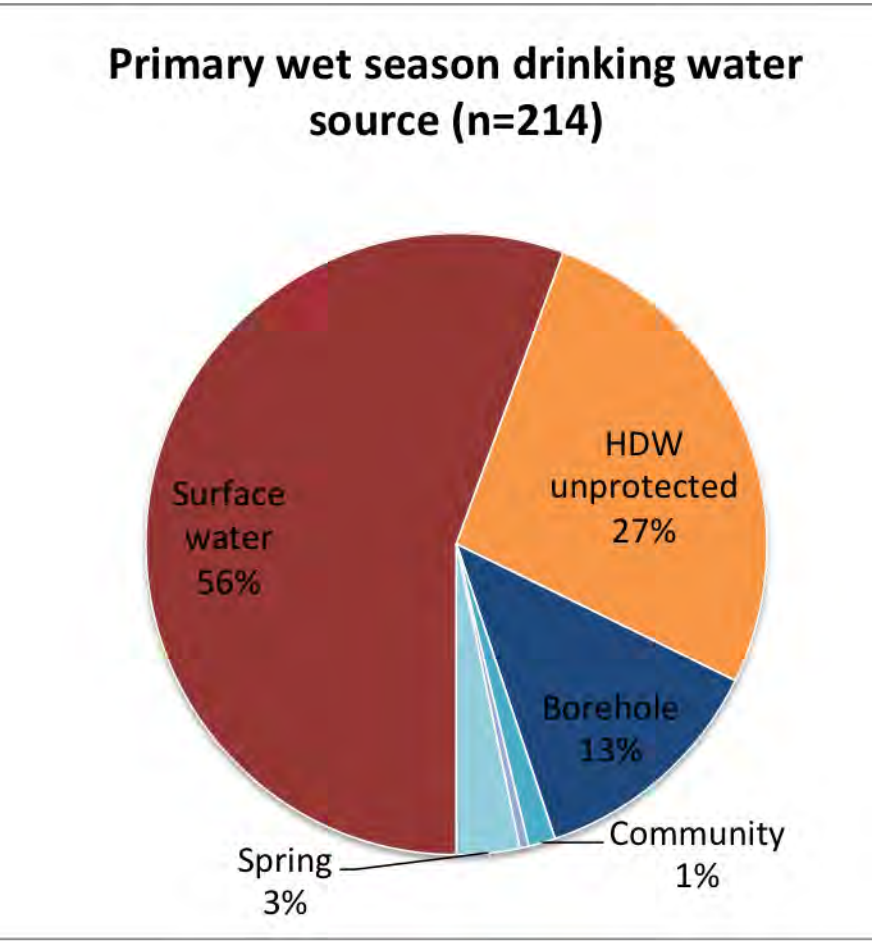


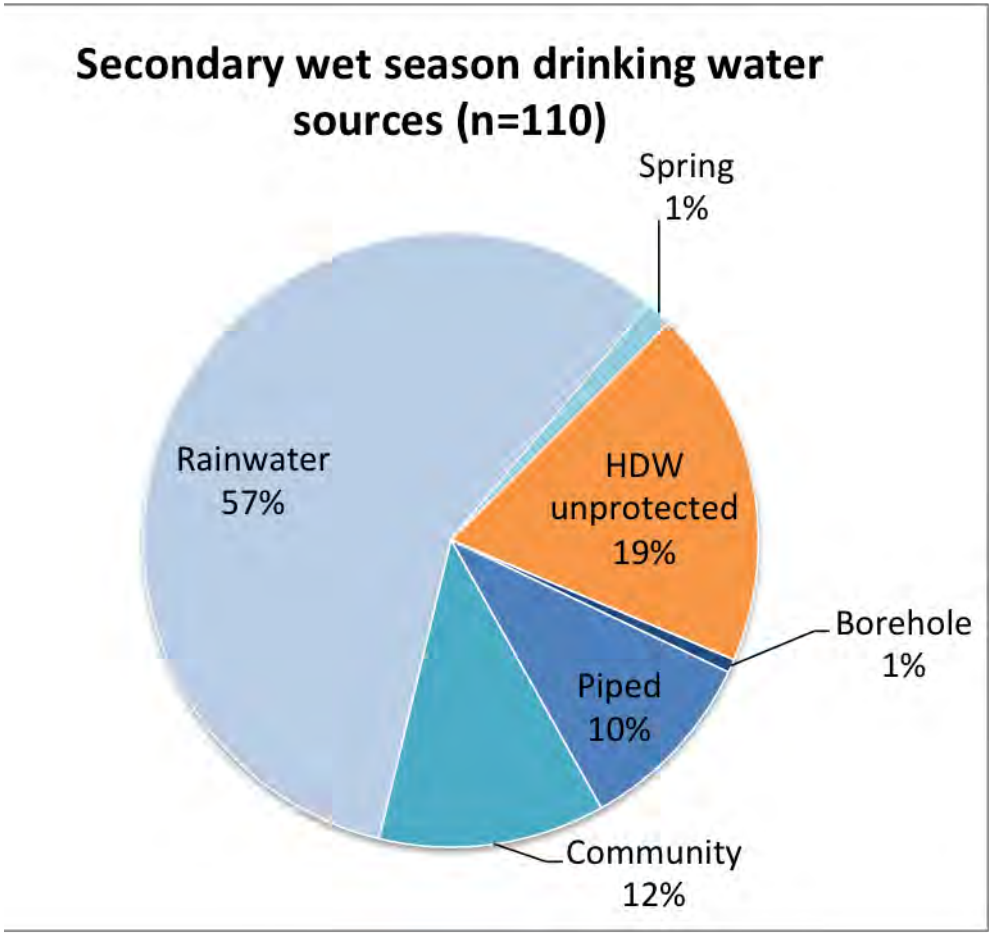
Drinking water source: Wet season

Primary wet season drinking water source (n=214)



Drinking water source: Wet season



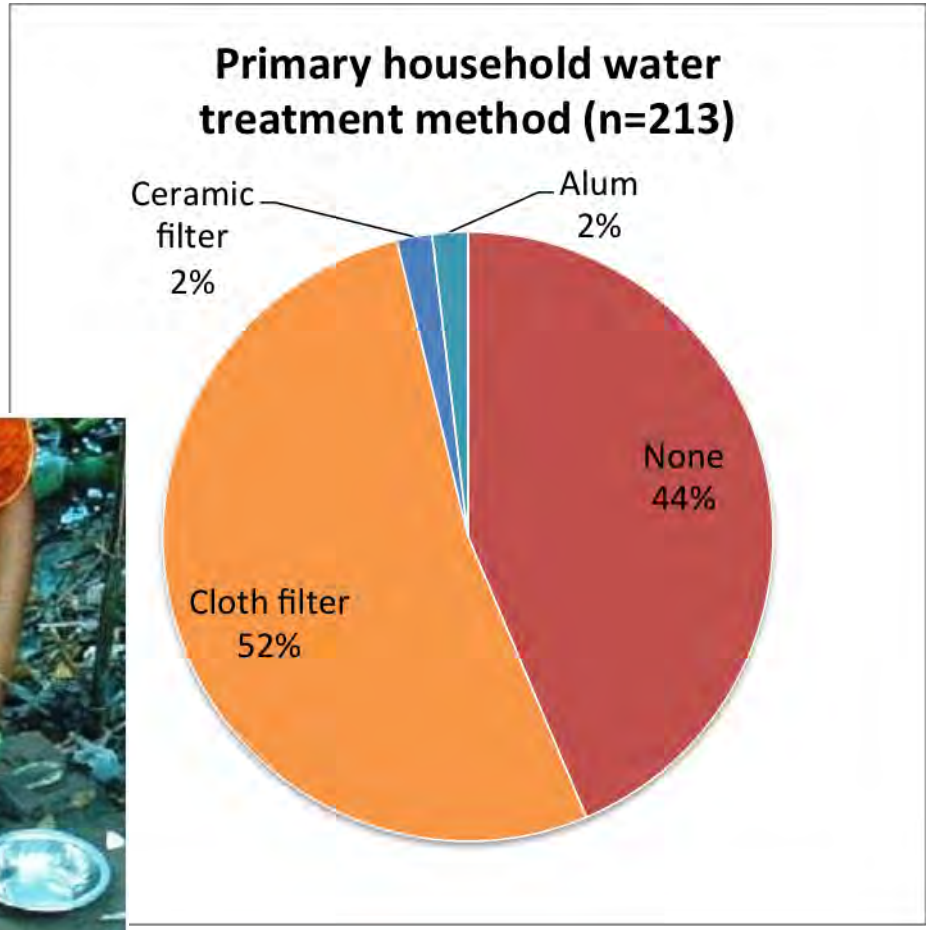


Household water treatment

- None
- Chlorine
- Alum
- Boiling
- Cloth filter
- Ceramic filter

Household water treatment

www.peterdicampo.com and www.sswm.info



Hand-washing with soap

1. Have you washed your hands in the past 24 hours?
   Yes No (SKIP NEXT TWO QUESTIONS)

2. In the past 24 hours, did you wash your hands _____? CIRCLE IF "YES"

   After toilet use After wiping child's behind After disposing of stools

   Before feeding child Before handling food Before eating

3. Do you use soap when washing your hands? Yes No

Hand-washing with soap

1. Have you washed your hands in the past 24 hours?
   Yes No (SKIP NEXT TWO QUESTIONS)
2. In the past 24 hours, did you wash your hands _____? CIRCLE IF "YES"

After toilet use	After wiping child's behind	After disposing of stools
Before feeding child	Before handling food	Before eating

3. Do you use soap when washing your hands? Yes No

Hand-washing with soap

Hand-washing with soap, try 1

Hand-washing with soap, try 2

7. Could you please show us what kind of soap you have in your home?

	Present	Not present

8. What do you use the soap for? CIRCLE ALL THAT APPLY, DO NOT PROMPT ANSWERS.

Handwashing	Dishes	Laundry	Other

Hand-washing with soap, try 2

7. Could you please show us what kind of soap you have in your home?

Present	Not present

8. What do you use the soap for? CIRCLE ALL THAT APPLY, DO NOT PROMPT ANSWERS.

Handwashing	Dishes	Laundry	Other

Hand-washing with soap, try 2

7. Could you please show us what kind of soap you have in your home?

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Handwashing Dishes Laundry Other

Hand-washing with soap, try 2

7. Could you please show us what kind of soap you have in your home?

	Present	Not present

8. What do you use the soap for? CIRCLE ALL THAT APPLY, DO NOT PROMPT ANSWERS.

Handwashing	Dishes	Laundry	Other

Hand-washing with soap, try 2

Soap presence

Health baseline

Age of household member:
Under 5 6 – 15 Over 15

Does household member normally go to school or work outside the home?
Go to school Work outside of home ~~Neither~~

We would like to know if _____ had diarrhea during the past week. On DAY, did HE/SHE have diarrhea? IF YES, ASK: How severe was the diarrhea? Was there blood or mucus in the stools? IF MEMBER NORMALLY GOES TO SCHOOL OR WORKS OUTSIDE THE HOME, ALSO ASK: Did HE/SHE miss SCHOOL/WORK because of the diarrhea?

(IF ASKED FOR CLARIFICATION: We define diarrhea as three or more loose or watery stools in a 24-hour period, or a single stool with blood or mucus.)

	Normal Stools	Diarrhea	Blood and/or mucus	Missed school /work
Monday	☺	☹ ☹ ☹ ☹ ☹	~~No~~	~~No~~
Tuesday	☺	☹ ☹ ☹ ☹ ☹	~~No~~	~~No~~
Wednesday	☺	☹ ☹ ☹ ☹ ☹	~~No~~	~~No~~
Thursday	☺	☹ ☹ ☹ ☹ ☹	~~No~~	~~No~~
Friday	☺	☹ ☹ ☹ ☹ ☹	~~No~~	~~No~~
Saturday	☺	☹ ☹ ☹ ☹ ☹	~~No~~	~~No~~
Sunday	☺	☹ ☹ ☹ ☹ ☹	~~No~~	~~No~~

We would also like to know if _____ had respiratory problems in the past week. This includes any cough or difficulty breathing. On DAY, did HE/SHE have respiratory problems? IF YES, ASK: How severe was the illness? IF MEMBER NORMALLY GOES TO SCHOOL OR WORKS OUTSIDE THE HOME, ALSO ASK: Did HE/SHE miss SCHOOL/WORK because of the illness?

	Normal	Respiratory problems?	Missed school /work
Monday	☺	😢 😢 😢 😢 😢	~~No~~
Tuesday	☺	😢 😢 😢 😢 😢	~~No~~
Wednesday	☺	😢 😢 😢 😢 😢	~~No~~
Thursday	☺	😢 😢 😢 😢 😢	~~No~~
Friday	☺	😢 😢 😢 😢 😢	~~No~~
Saturday	☺	😢 😢 😢 😢 😢	~~No~~
Sunday	☺	😢 😢 😢 😢 😢	~~No~~

Health baseline

Diarrhea and Respiratory Disease

We will now ask you some questions about the health status of your family. We will be asking about diarrhea and respiratory illness. If you do not feel comfortable with sharing this information please tell us.

SKIP 11 IF THERE ARE NO CHILDREN UNDER 5 IN HOUSEHOLD.

9. Let's start with your youngest child. USE **FORM A** FOR EACH CHILD UNDER AGE 5.

Health baseline

FORM A

Questions	Youngest under age 5	Next youngest	Next youngest	Next youngest	Eldest under age 5
A1. Has he/she had diarrhea in the last 2 days?	Yes No	Yes No	Yes No	Yes No	Yes No
IF HE/SHE HAD DIARRHEA: A2. Was the diarrhea severe or watery?	Yes No	Yes No	Yes No	Yes No	Yes No
A3. Has he/she had blood or mucus present in his/her stool?	Yes No	Yes No	Yes No	Yes No	Yes No
A4. Has he/she vomited in the last 2 days?	Yes No	Yes No	Yes No	Yes No	Yes No
A5. Has he/she had a cough or difficulty breathing in the last 2 days?	Yes No	Yes No	Yes No	Yes No	Yes No
IF HE/SHE HAD A COUGH OR DIFFICULTY BREATHING: A6. Was the cough or difficulty breathing severe?	Yes No	Yes No	Yes No	Yes No	Yes No

Health baseline

10. Has anyone (else) in the household had diarrhea or abdominal pain in the last two days?
    Yes No

11. Has anyone (else) in the household had blood or mucus in the stool in the last two days?
    Yes No

12. Has anyone (else) in the household had nausea or vomited in the last two days?
    Yes No

USE **FORM B** FOR EACH PERSON WHO HAS HAD ANY OF ABOVE SYMPTOMS IN THE LAST WEEK.

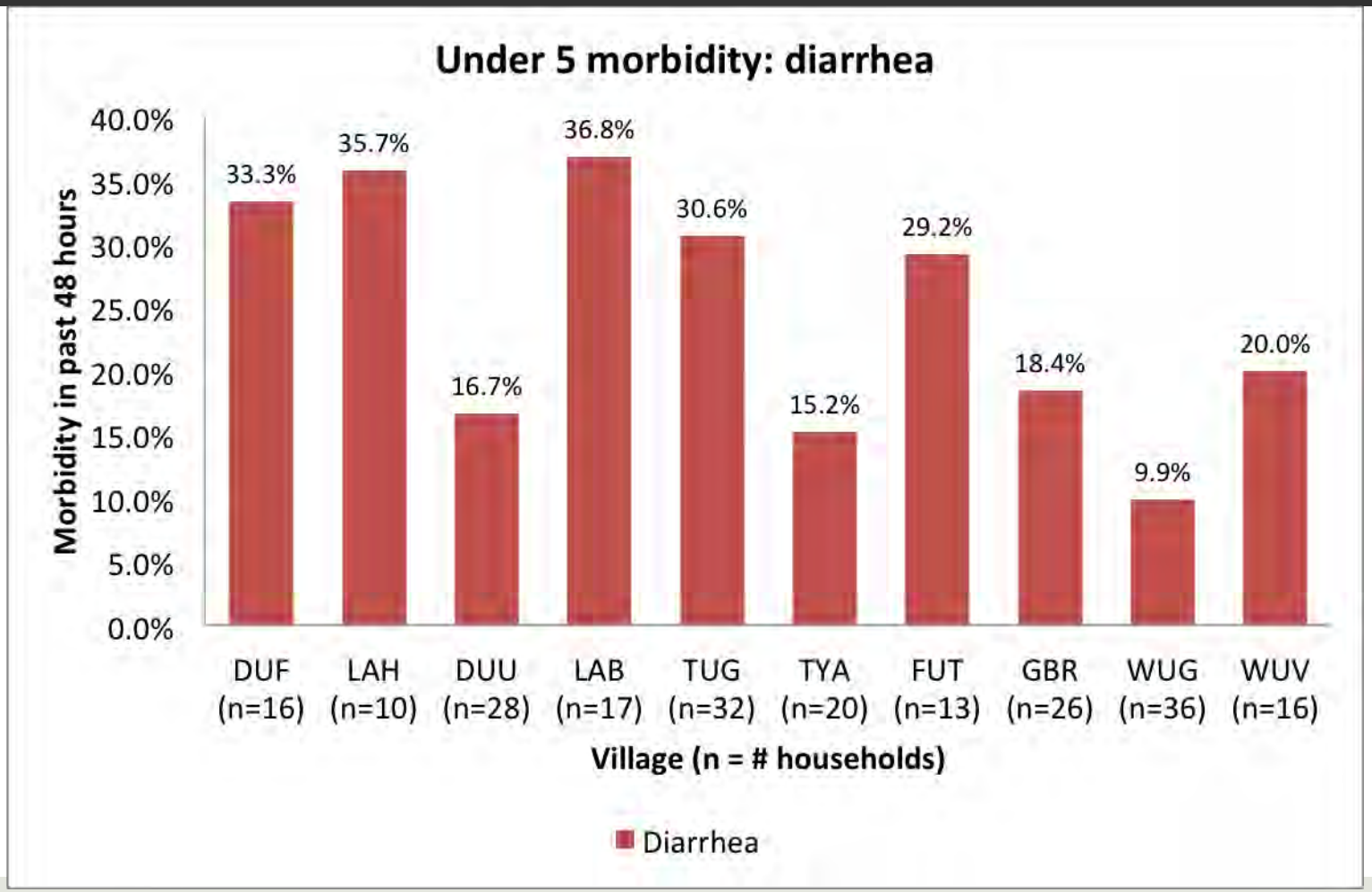
Health baseline

FORM B

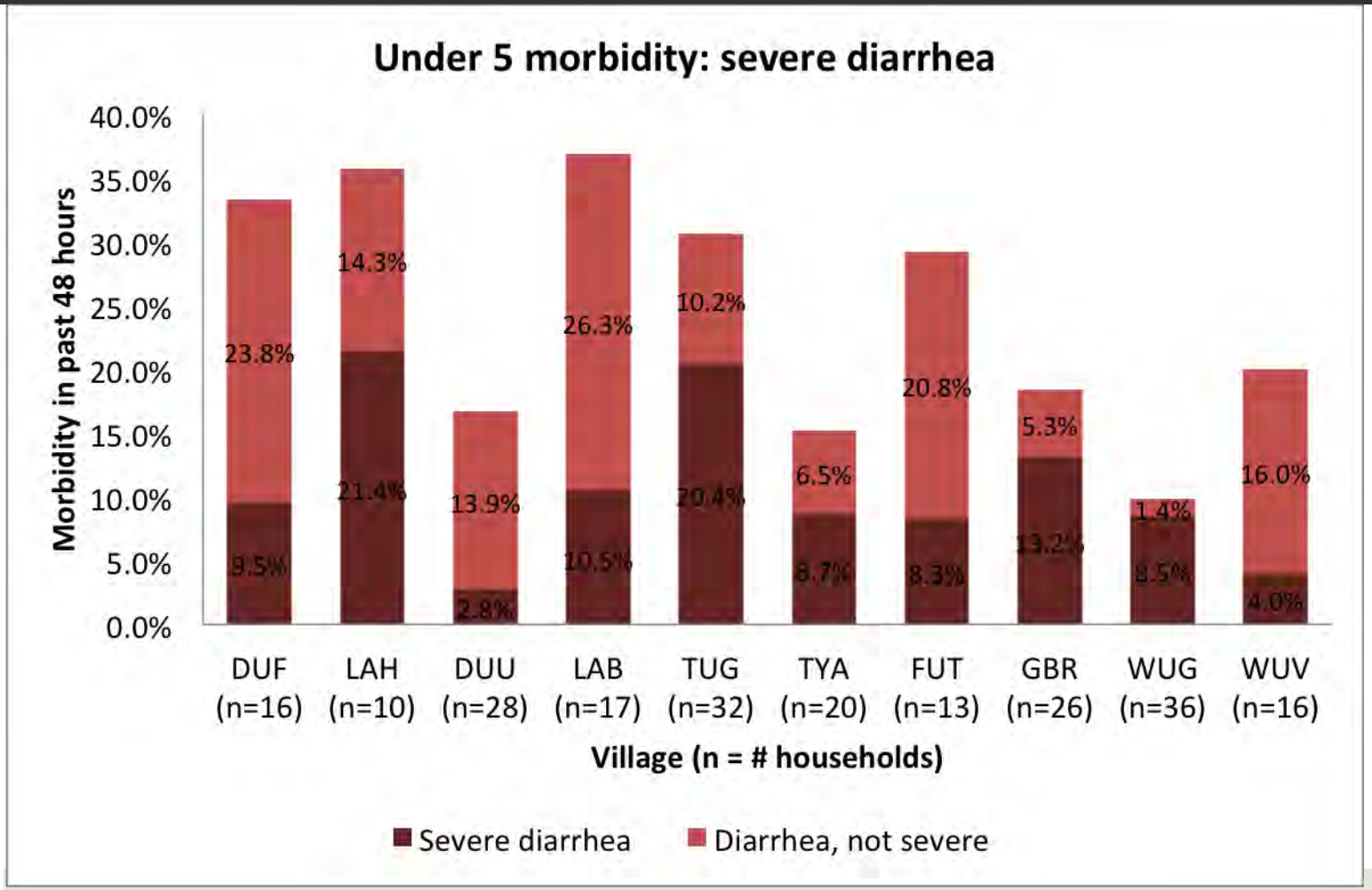
Questions	Person 1	Person 2	Person 3	Person 4	Person 5
B1. Which symptoms did the individual have? LIST AS NECESSARY (HCGI = PRESENCE OF ANY: WATER DIARRHEA, VOMITING, SOFT DIARRHEA W/ ABDOM PAIN, OR NAUSEA W/ ABDOM PAIN; DIARRHEA = THREE OR MORE LOOSE OR WATERY STOOLS IN 24 HOURS OR A SINGLE STOOL W/ BLOOD OR MUCUS)	Diarrhea Abdom. Pain Vomiting Nausea Blood/mucus in stool	Diarrhea Abdom. Pain Vomiting Nausea Blood/mucus in stool	Diarrhea Abdom. Pain Vomiting Nausea Blood/mucus in stool	Diarrhea Abdom. Pain Vomiting Nausea Blood/mucus in stool	Diarrhea Abdom. Pain Vomiting Nausea Blood/mucus in stool
IF HE/SHE HAD DIARRHEA: B2. Was the diarrhea severe or watery?	Yes No	Yes No	Yes No	Yes No	Yes No

Questions	Person 6	Person 7	Person 8	Person 9	Person 10
B1. Which symptoms did the individual have? LIST AS NECESSARY (HCGI = PRESENCE OF ANY: WATER DIARRHEA, VOMITING, SOFT DIARRHEA W/ ABDOM PAIN, OR NAUSEA W/ ABDOM PAIN; DIARRHEA = THREE OR MORE LOOSE OR WATERY STOOLS IN 24 HOURS OR A SINGLE STOOL W/ BLOOD OR MUCUS)	Diarrhea Abdom. Pain Vomiting Nausea Blood/mucus in stool	Diarrhea Abdom. Pain Vomiting Nausea Blood/mucus in stool	Diarrhea Abdom. Pain Vomiting Nausea Blood/mucus in stool	Diarrhea Abdom. Pain Vomiting Nausea Blood/mucus in stool	Diarrhea Abdom. Pain Vomiting Nausea Blood/mucus in stool
IF HE/SHE HAD DIARRHEA: B2. Was the diarrhea severe or watery?	Yes No	Yes No	Yes No	Yes No	Yes No

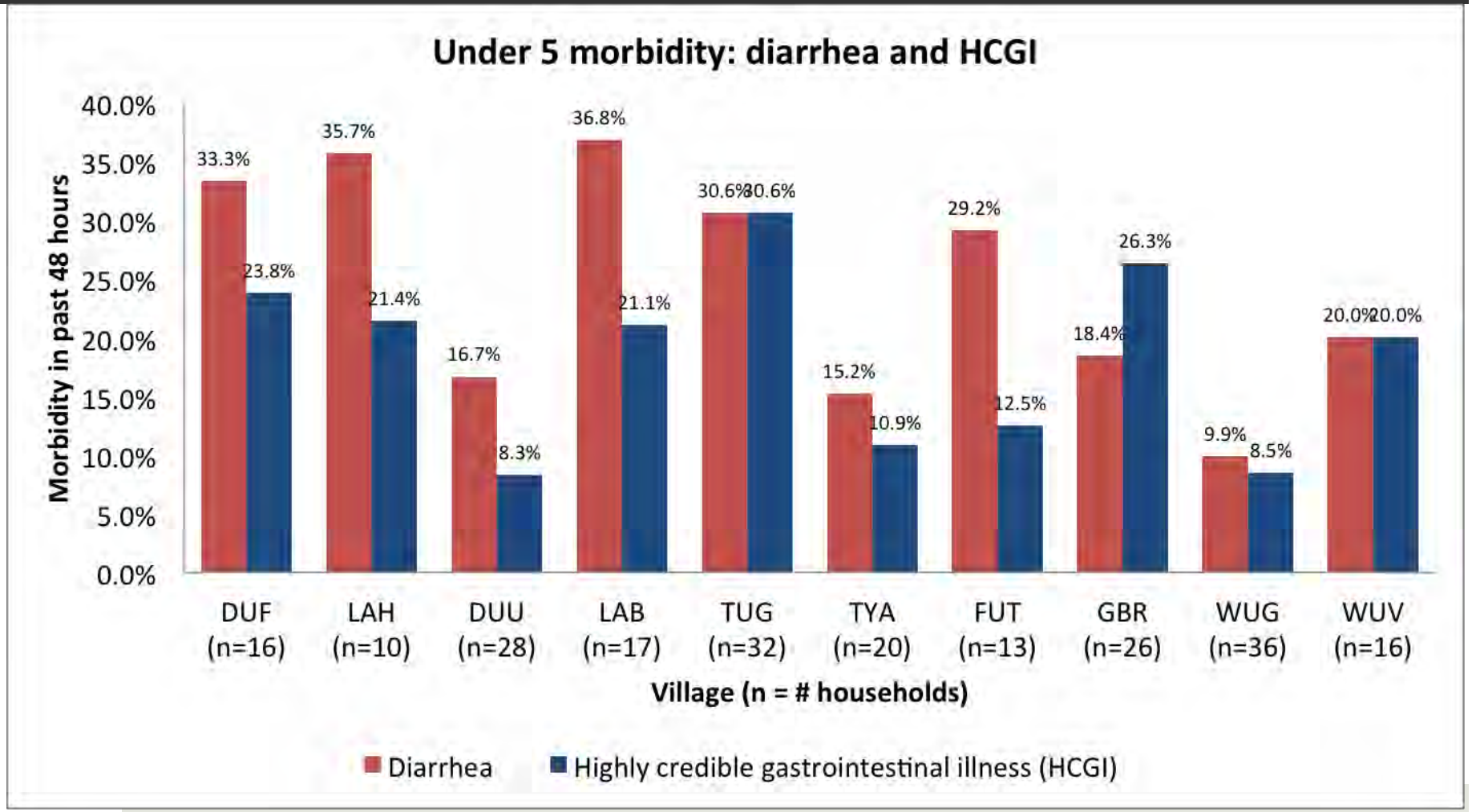
Under 5 morbidity: Diarrhea



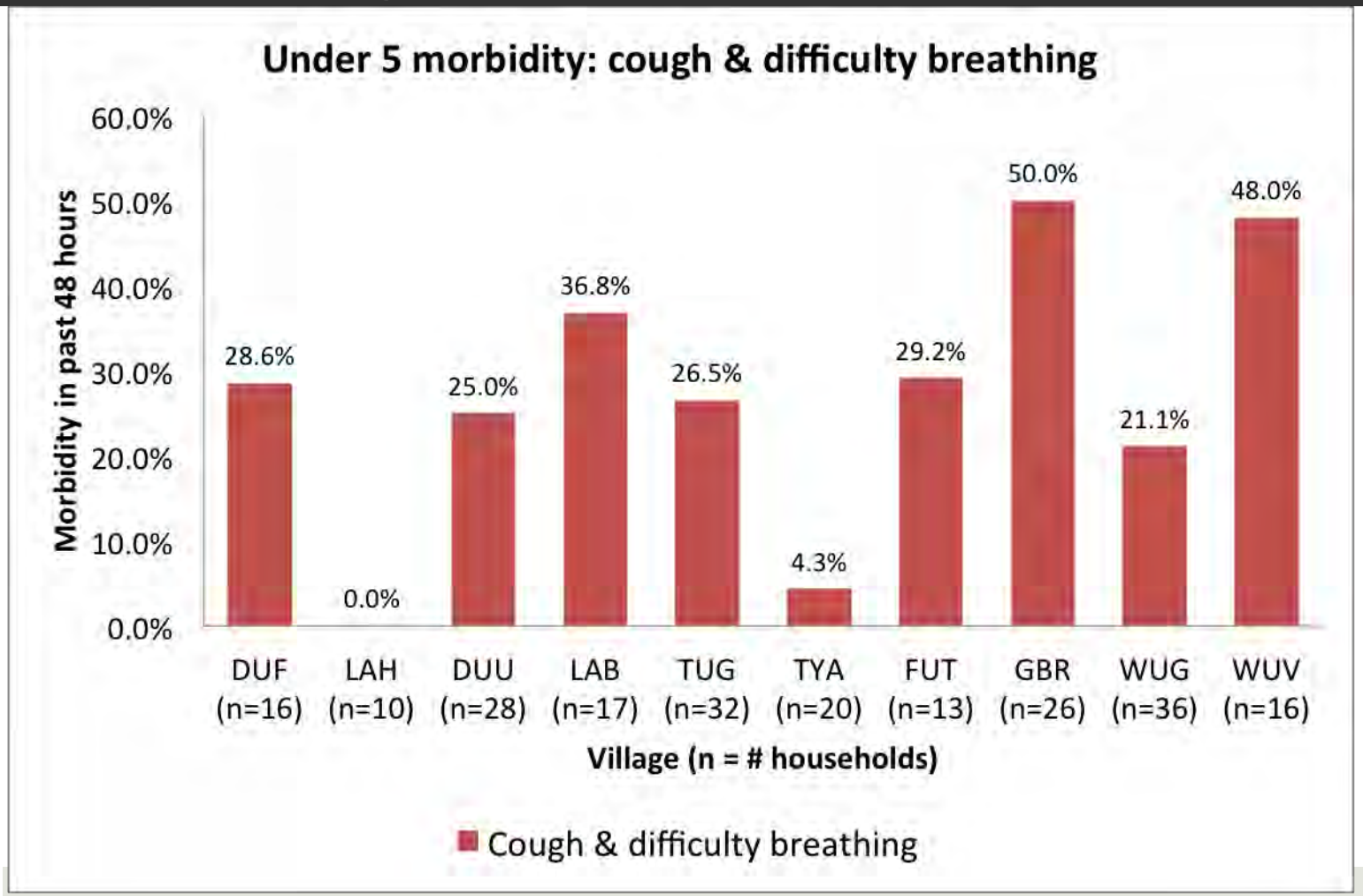
Under 5 morbidity: Severe diarrhea



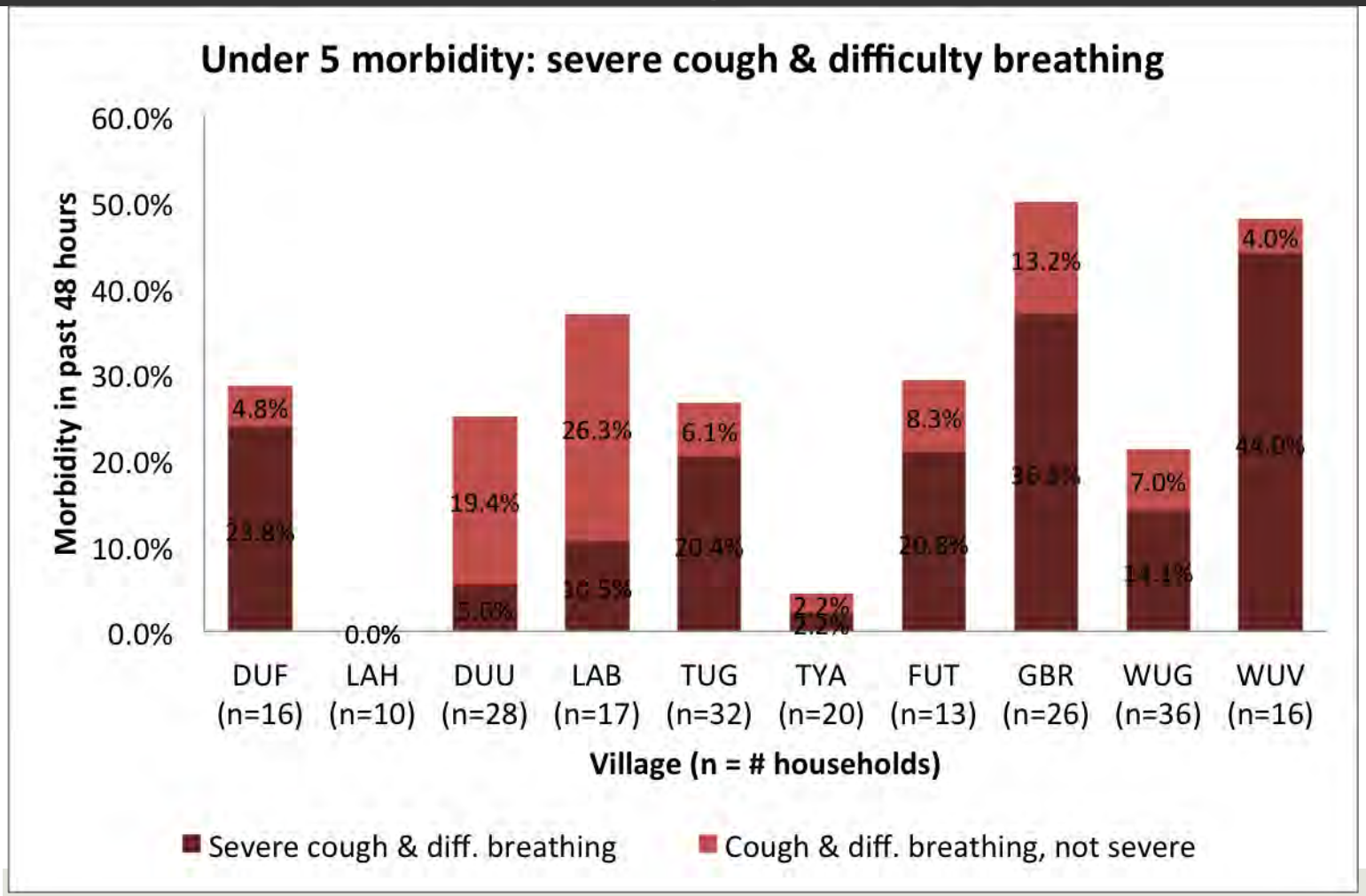
Under 5 morbidity: HCGI



Under 5 morbidity: cough & difficulty breathing



Under 5 morbidity: severe cough & difficulty breathing



A FEW OF THE limitations

- Significant uncertainty in accuracy of survey responses
  - Does not know answer
  - Cannot recall event
  - Being polite
- Difference in manner of soliciting and interpreting survey responses
- Village heterogeneity

Conclusion? Not yet.

(Appendix) Study framework

- Baseline

  Before dissemination

  + Household profile
  Water use practices
  Hand washing practices
  + Diarrhea & respiratory illness incidence

- User Adoption

  1-month follow-up

  Water use practices
  Hand washing practices

- Sustained Use

  &Health Impact

  4- to 6-month follow-up

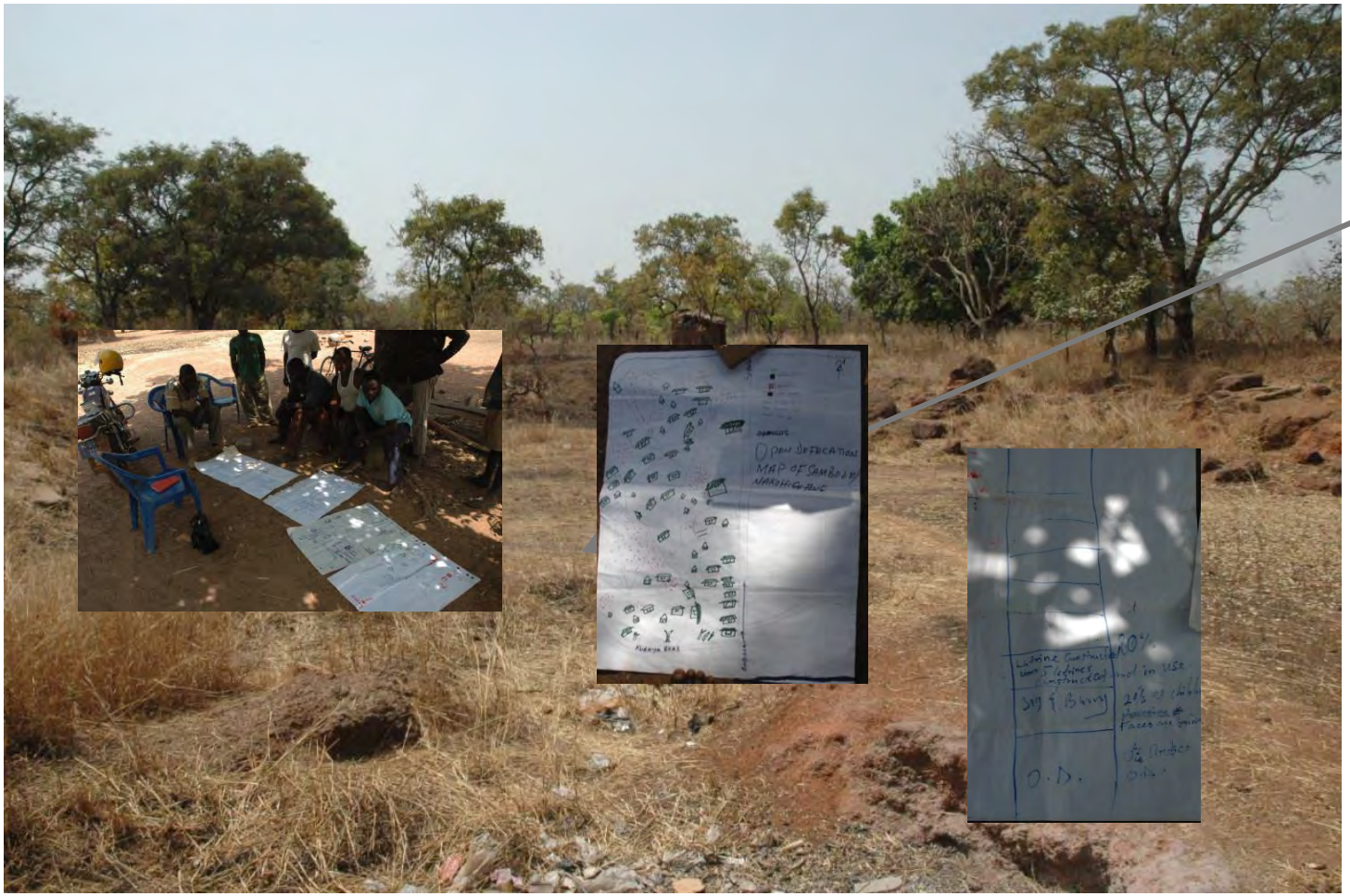
  + Household profile
  Water use practices
  Hand washing practices
  + Diarrhea & respiratory illness incidence

EVALUATION OF SANITATION INITIATIVES IN RURAL GHANA

ADAM QUESTAD

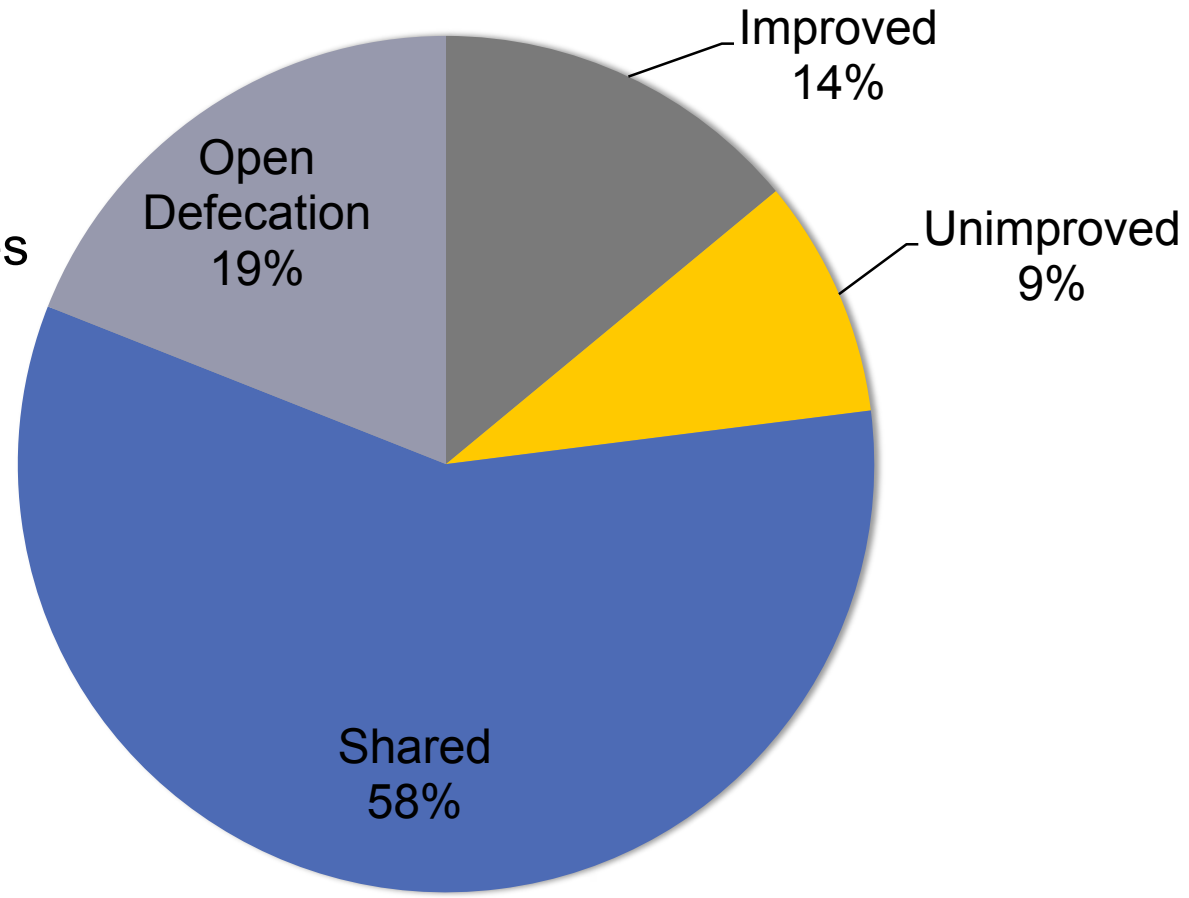
SANITATION IN RURAL GHANA

SANITATION IN RURAL GHANA



SANITATION IN RURAL GHANA

- Current Human Waste Disposal
  - Pit Latrines
  - Kumasi Ventilated Improved Pit Latrines (KVIP)
  - Public Toilets
  - EcoSan
  - Bucket Latrines



Sanitation Coverage in Ghana (%)

OBJECTIVES

Evaluate the I-WASH project (Integrated Approach to Guinea Worm Eradication through Water Supply, Sanitation and Hygiene)

Evaluate CLTS (Community-led Total Sanitation) approach

Recommendations for the future

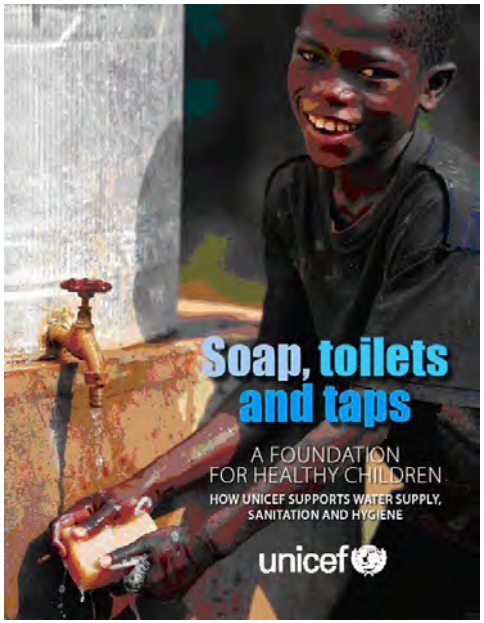
BACKGROUND

I-WASH

- UNICEF and European Commission
- $25.8 Million Budget
- 16% of Budget (roughly $4 Million) towards improved sanitation coverage
- Nine districts in Northern Ghana
- 48,000 latrines goal
    - 3,100 actual construction after 4 years

CLTS

- Triggering among communities
- Encourages communities to act
- Subsidy-free intervention
- Create Open Defecation Free (ODF) communities



http://www.unicef.org

http://www.communityledtotalsanitation.org/page/clts-photos

INTERNATIONAL DEVELOPMENT EXPERTS

Jim Niquette
Former Director of the Carter Center's Guinea Worm Eradication Campaign

Jeff Chapin
Designer for IDEO

Nat Paynter
Director of Water Programs for Charity:Water

Michael Kremer
Gates Professor of Development Societies at Harvard University

EXPERT INTERVIEWS AND COMMUNITY MEETINGS

EXPERT INTERVIEWS AND COMMUNITY MEETINGS

NEW PROJECT INITIATIVES AND ALTERNATE TECHNOLOGIES

Uni-Lever IDEO WSUP

Uni-loo & The Clean Team

Sanivation

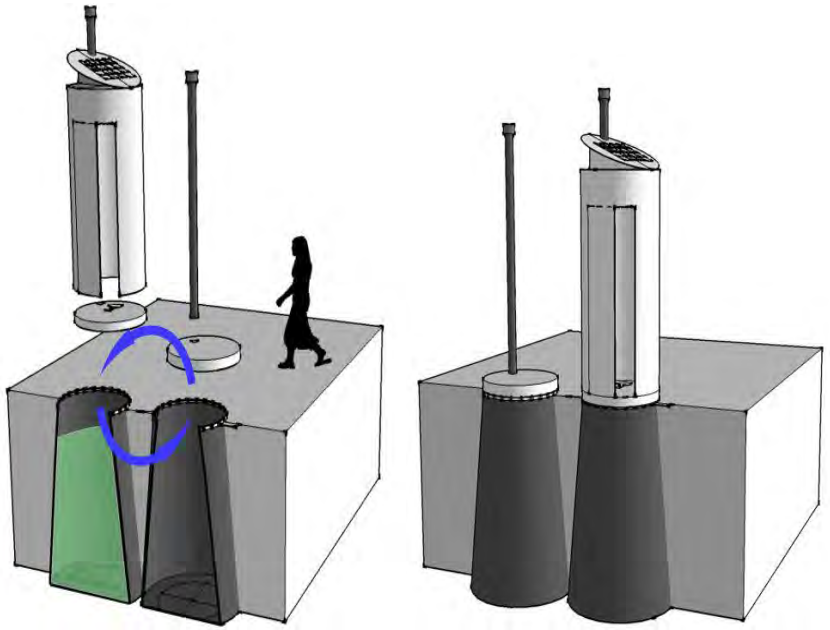
Solar Concentrator

NEW PROJECT INITIATIVES AND ALTERNATE TECHNOLOGIES

Ghana Sustainable Aid Project

Micro-flush Bio-fill Toilet

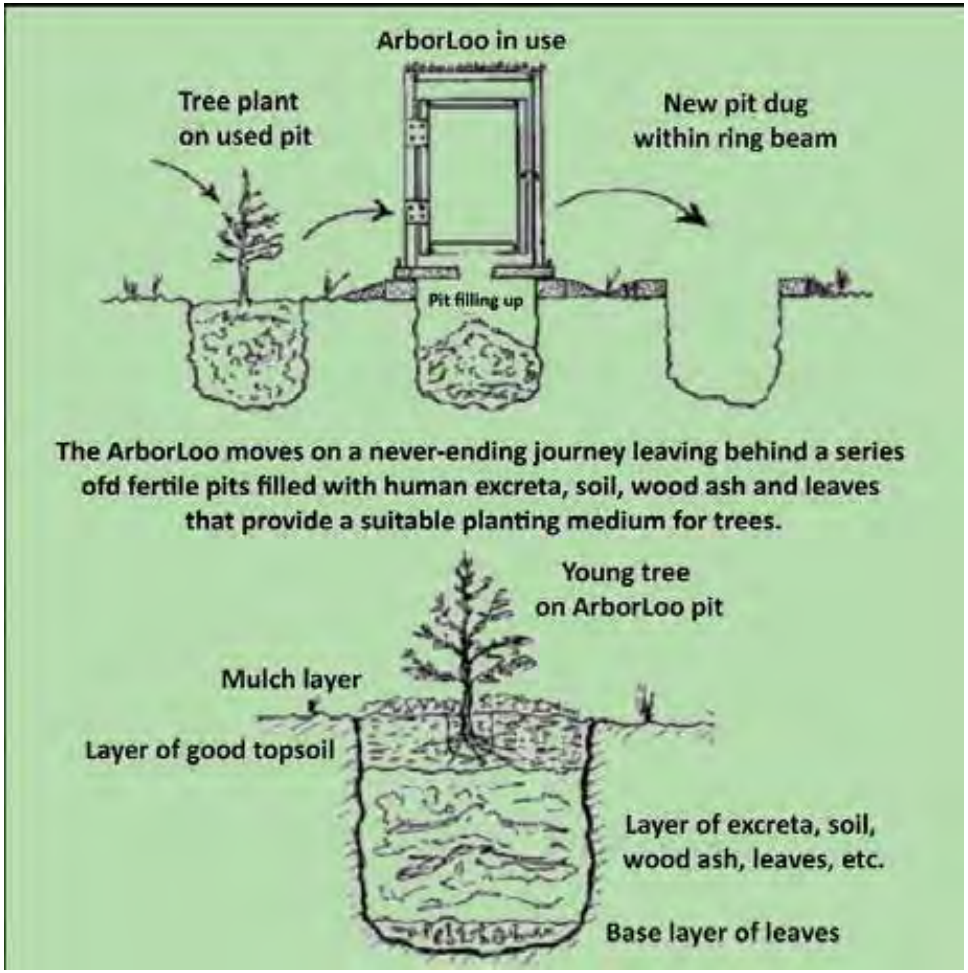
Small Small



Global Latrine

NEW PROJECT INITIATIVES AND ALTERNATE TECHNOLOGIES

The ArborLoo



LATRINE TECHNOLOGIES EVALUATION

ArborLoo

Simple Pit Latrine (Un-lined)

Simple Pit Latrine (Lined)

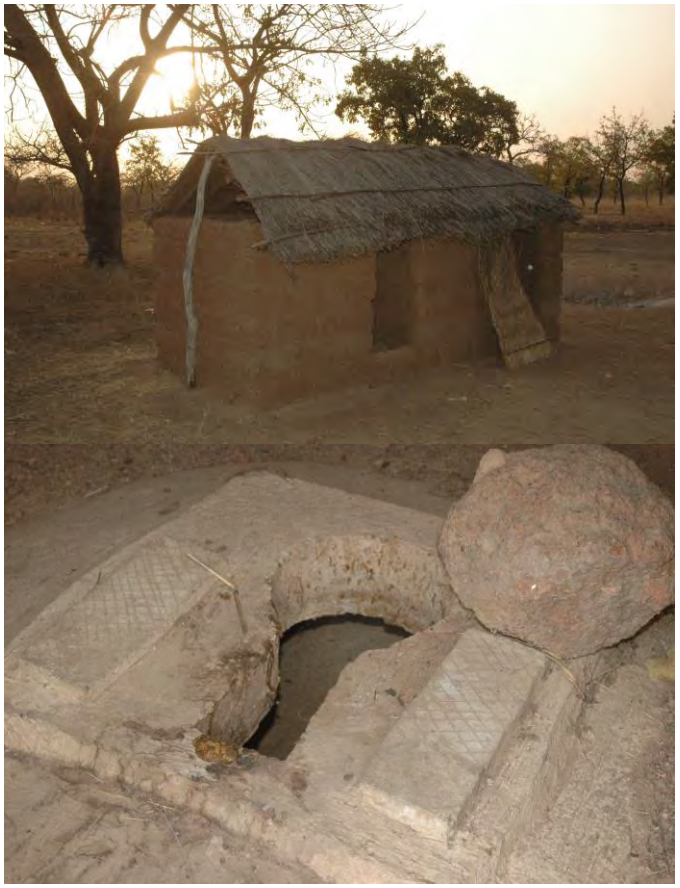
Urine Diverting Dry Toilet (EcoSan)

Micro-Flush Bio-Fill (MFBF)

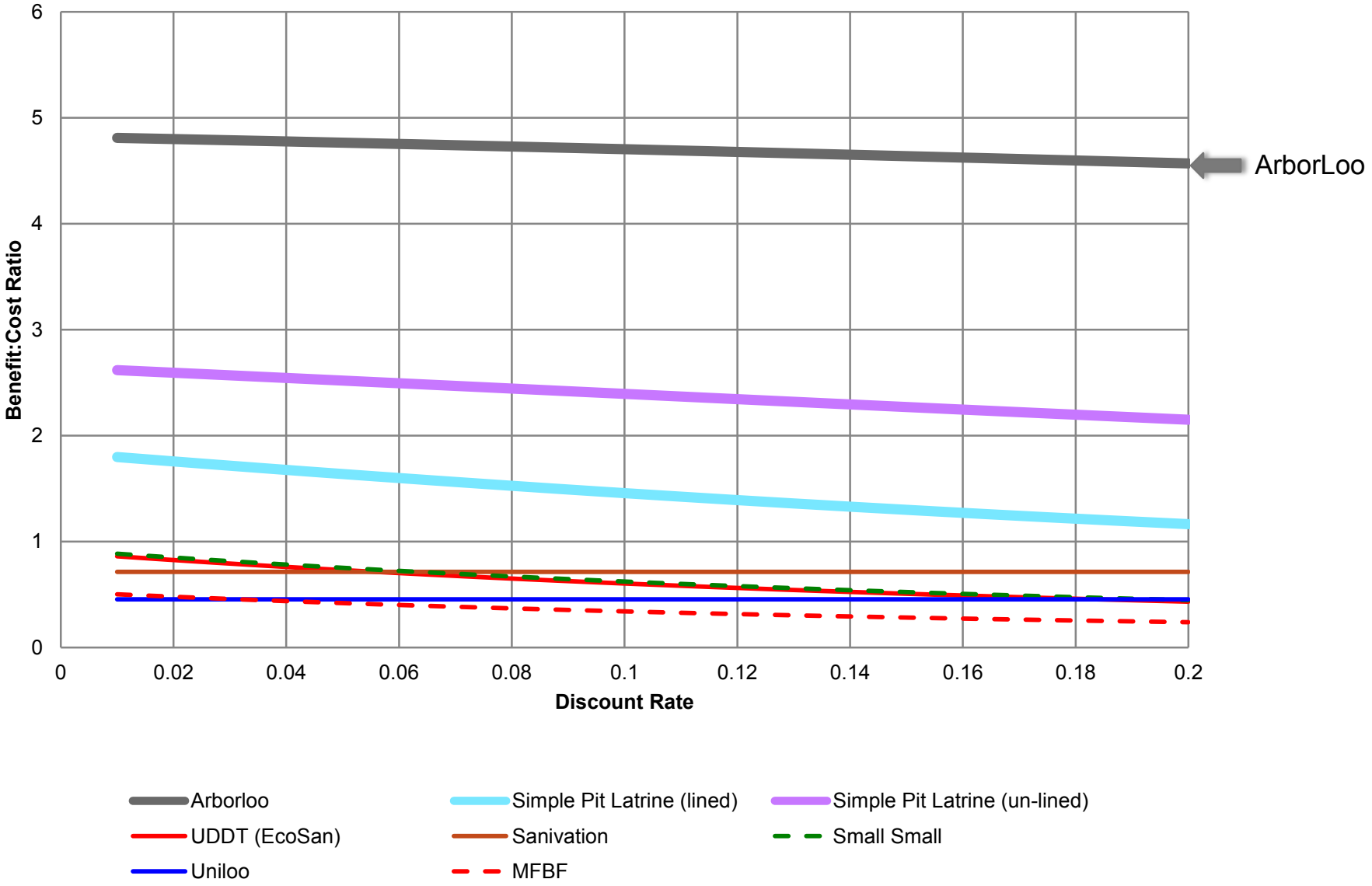
Sanivation

Small Small

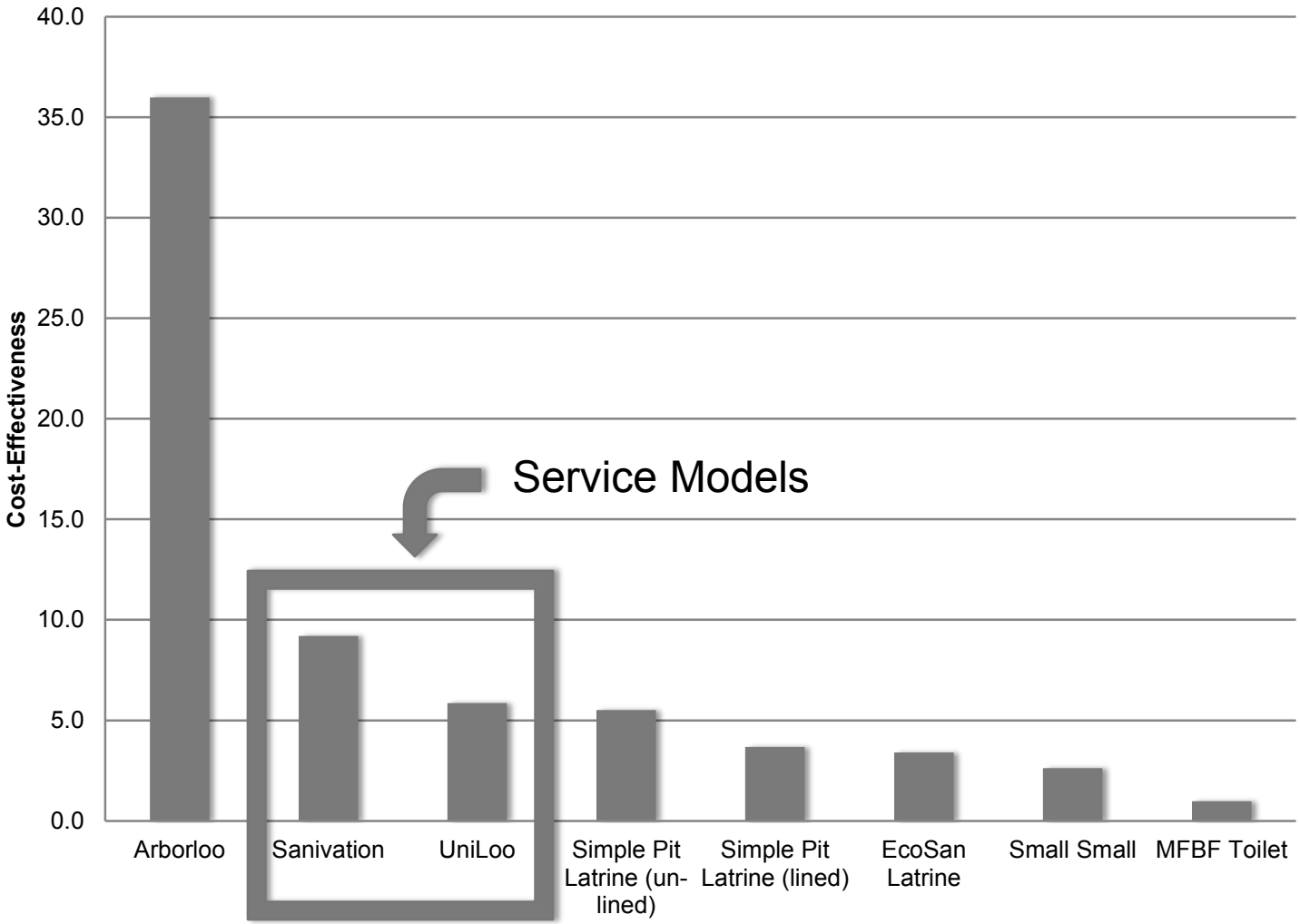
UniLoo



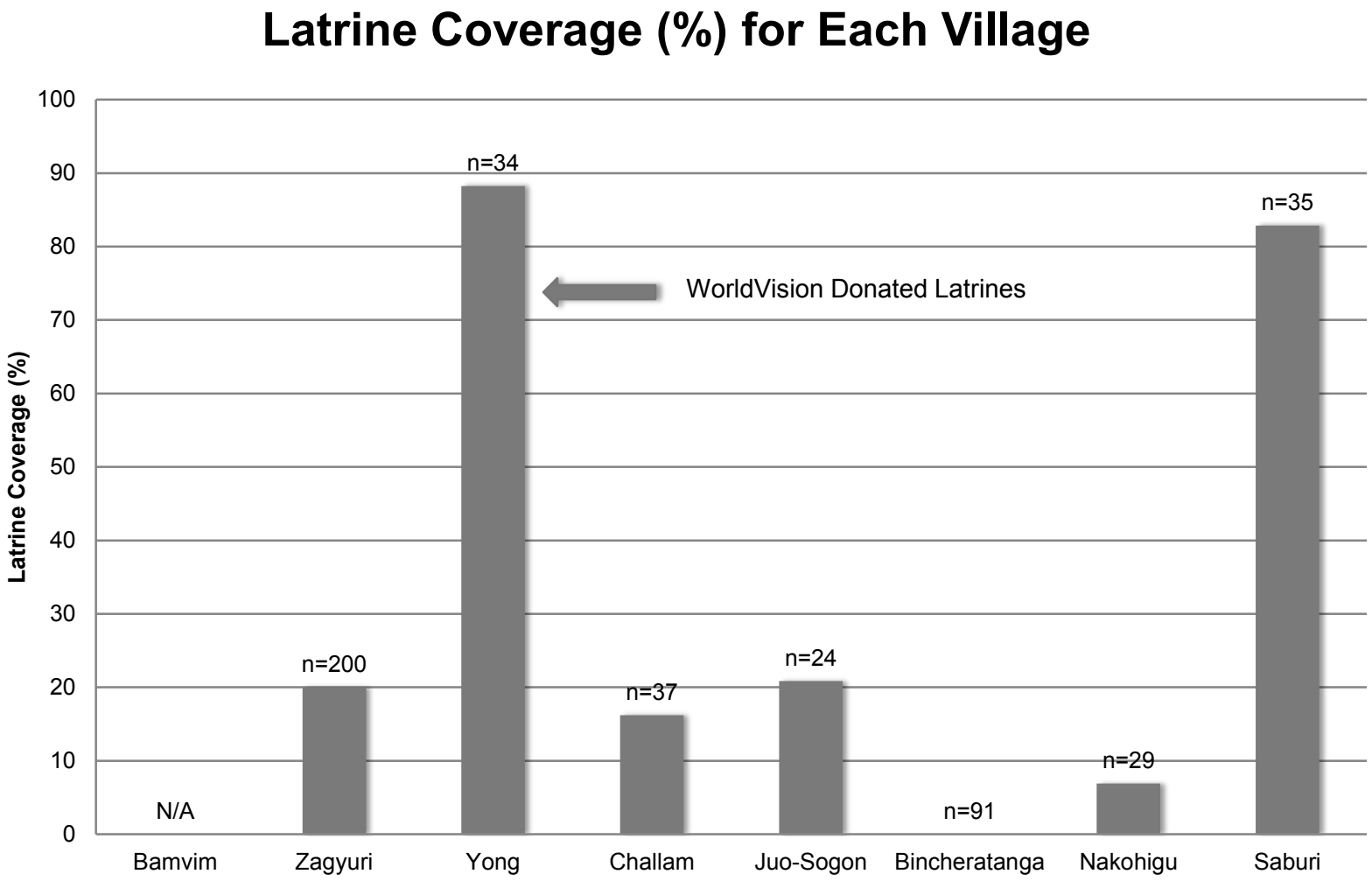
BENEFIT:COST OF LATRINE TECHNOLOGIES



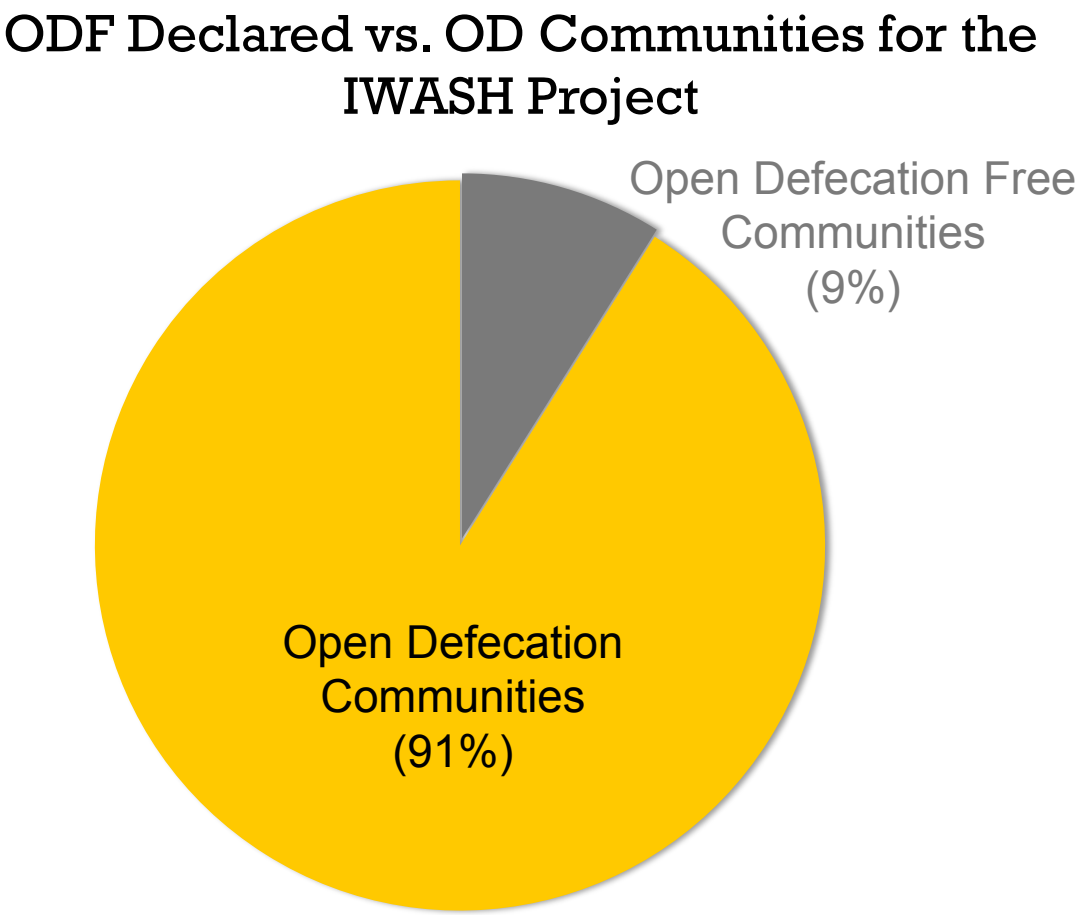
COST-EFFECTIVENESS ANALYSIS



VILLAGE RESULTS



VILLAGE RESULTS



OBSERVANCES

Need Resources (Money and Education)

Uneven Distribution of Aid (Subsidy vs. Free)

Minimal Monitoring (1% of Entire I-WASH Budget)

Limited Sanitation Market

No Technical Support

RECOMMENDATIONS FOR THE GOV'T

National Laws/Policies and Building code enforcement (Punishment)

- Equitable distribution of sanitation interventions
- NGO and Government Harmonization

Monitoring, Re-triggering, and Goals (Incentive)

- Partnerships with villages
- Public Recognition

RECOMMENDATIONS FOR NGOS

Coordinate with Government

- Target CLTS communities

Provide technical support

- Subsidies to begin
- ArborLoo

Provide access to a sanitation market

- Service Model
- Technology Options

RECOMMENDATIONS FOR PURE HOME WATER

Target schools for latrine construction

- Train villagers during construction

Create Sanitation “store”

Conduct surveys

- Willingness to pay
- Demand for certain technologies

THANKS!

Photo courtesy of Winnie Qiu

GHANA'S REGIONAL DEVELOPMENT IN ECONOMICS, EDUCATION & NATURAL RESOURCES, WITH A CASE STUDY ON CUSTOMERS' PREFERENCES FOR HOUSEHOLD WATER TREATMENT & SAFE STORAGE PRODUCTS

WEINI QIU

NOV 20, 2012

PART I
GHANA'S REGIONAL DEVELOPMENT IN ECONOMICS, EDUCATION & NATURAL RESOURCES

DEVELOPMENT & MDG

Development trajectories – complex issues

- **Sustainable development**
- **Human development index**
- **Sustainable livelihoods framework**
- **Inclusive wealth index/framework**
- **Millennium Development Goals (MGDs)**

DEVELOPMENT & MDG

Development trajectories – complex issues

- Sustainable development
- Human development index
- Sustainable livelihoods framework
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- **Millennium Development Goals (MGDs)**

DEVELOPMENT & MDG

Development trajectories – complex issues

- Sustainable development
- Human development index
- Sustainable livelihoods framework
- Inclusive wealth index/framework
- **Millennium Development Goals (MGDs)**
  - Goal 1: Eradicate extreme poverty and hunger
  - Goal 2: Achieve universal primary education
  - Goal 3: Promote gender equality and empower women
  - Goal 4: Reduce child mortality
  - Goal 5: Improve maternal health
  - Goal 6: Combat HIV/AIDS, malaria & other diseases
  - Goal 7: Ensure environmental sustainability
  - Goal 8: Develop a global partnership for development

TARGETED MDGS

Goal 1: End Poverty

- **Target 1.A: Halve, the proportion of people whose income is less than $1 a day**

Goal 2: Universal Education

- Target 2.A: Ensure that children everywhere will be able to complete a full course of primary schooling

Goal 7: Environmental Sustainability

- Target 7.A: Integrate principles of sustainable development
- Target 7.C: Halve the proportion of the population without sustainable access to safe drinking water

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Goal 7: Environmental Sustainability

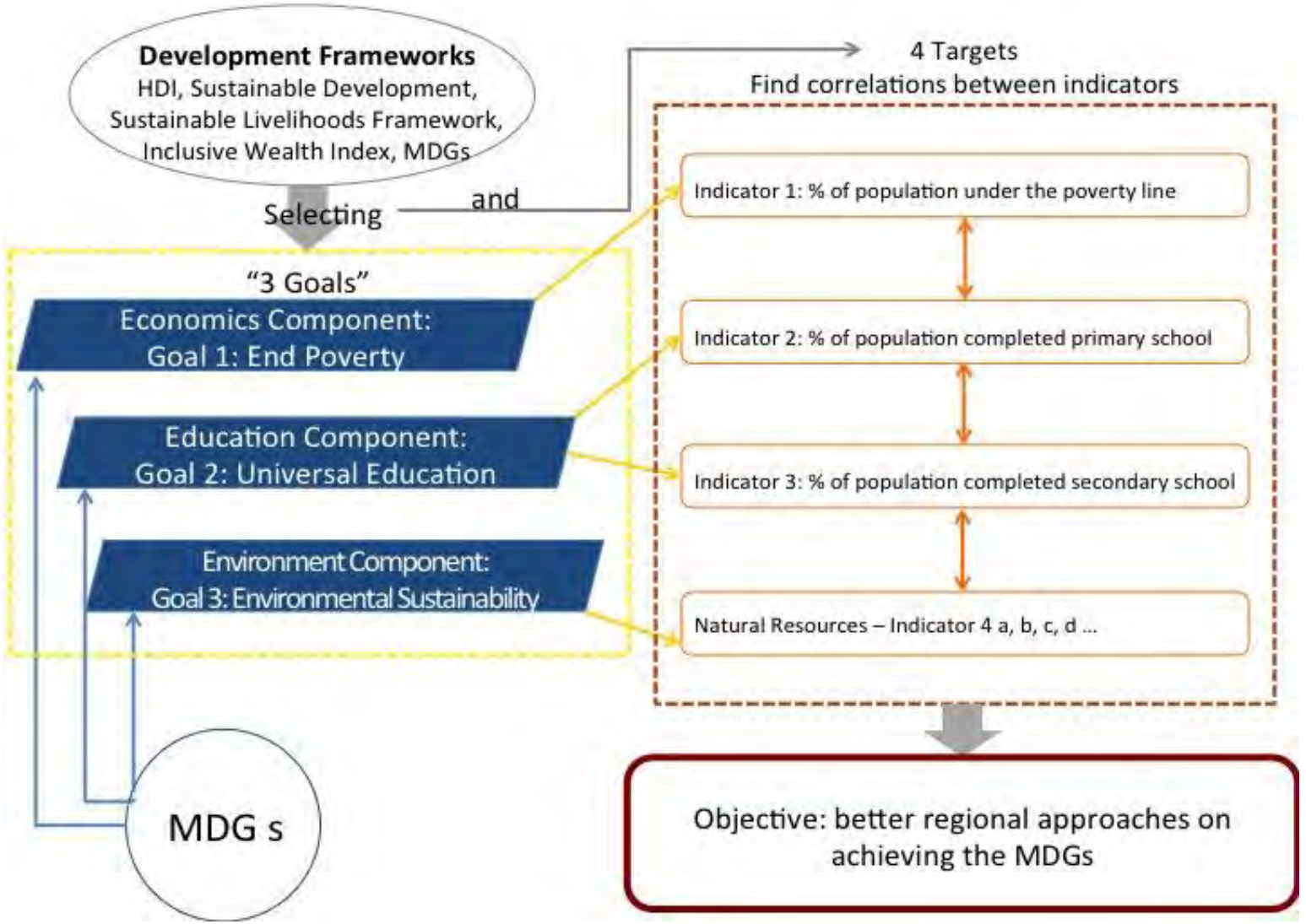
- **Target 7.A: Integrate principles of sustainable development**
- **Target 7.C: Halve the proportion of the population without sustainable access to safe drinking water**

WHY GHANA?

- Economics challenges
- Education challenges
- Environmental challenges

Ghana is facing REGIONAL and NATIONAL challenges in development!

THE BIG PICTURES



DATA COLLECTION

Data required:

- **National data – background**
- **Regional data – detailed analysis**
  - Economics data: % of population under the poverty line in each region
  - Education data: % of population that has completed primary and secondary schools;
  - Natural resources data: mean time to drinking water source, average annual precipitation; cocoa production, land use for oil palm

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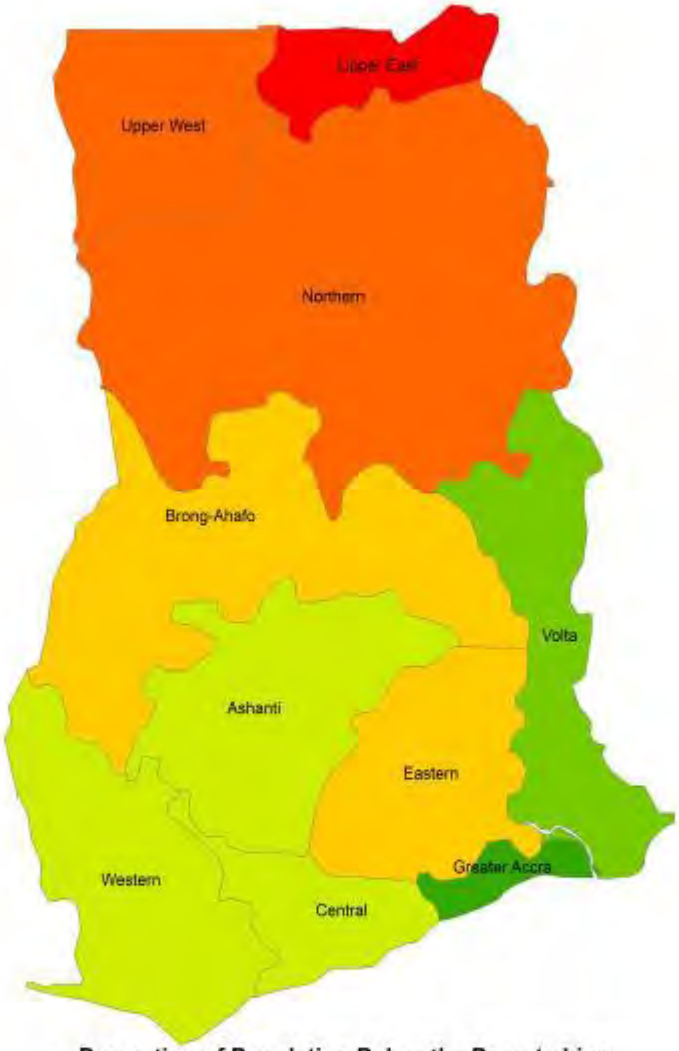
ATTENTION! Types of data collected is based on availability of public data.

POVERTY

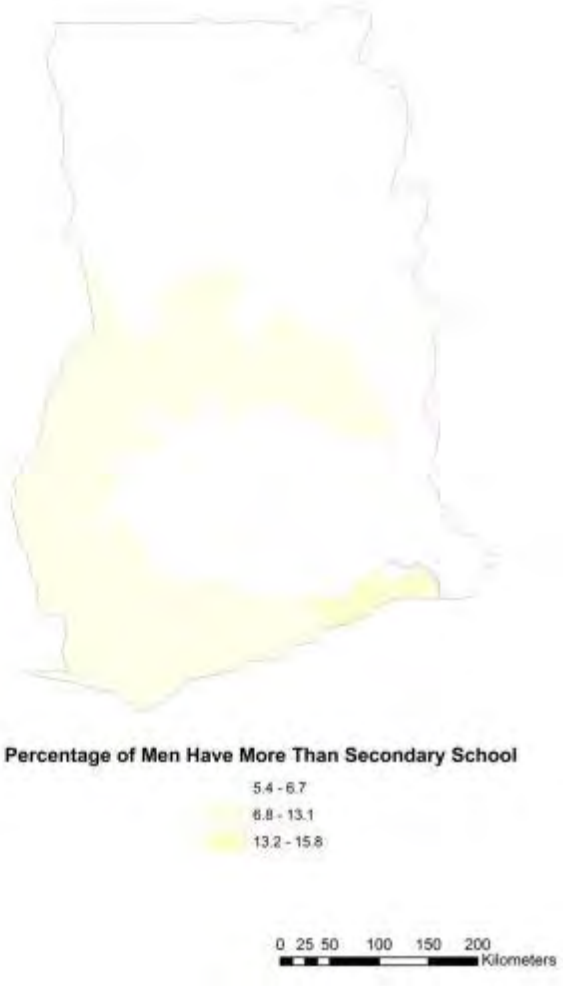
More than 2.5 million people earn < $1.25 per day in the three Northern Sector:

- **Upper East**
- **Upper West**
- **Northern Region**



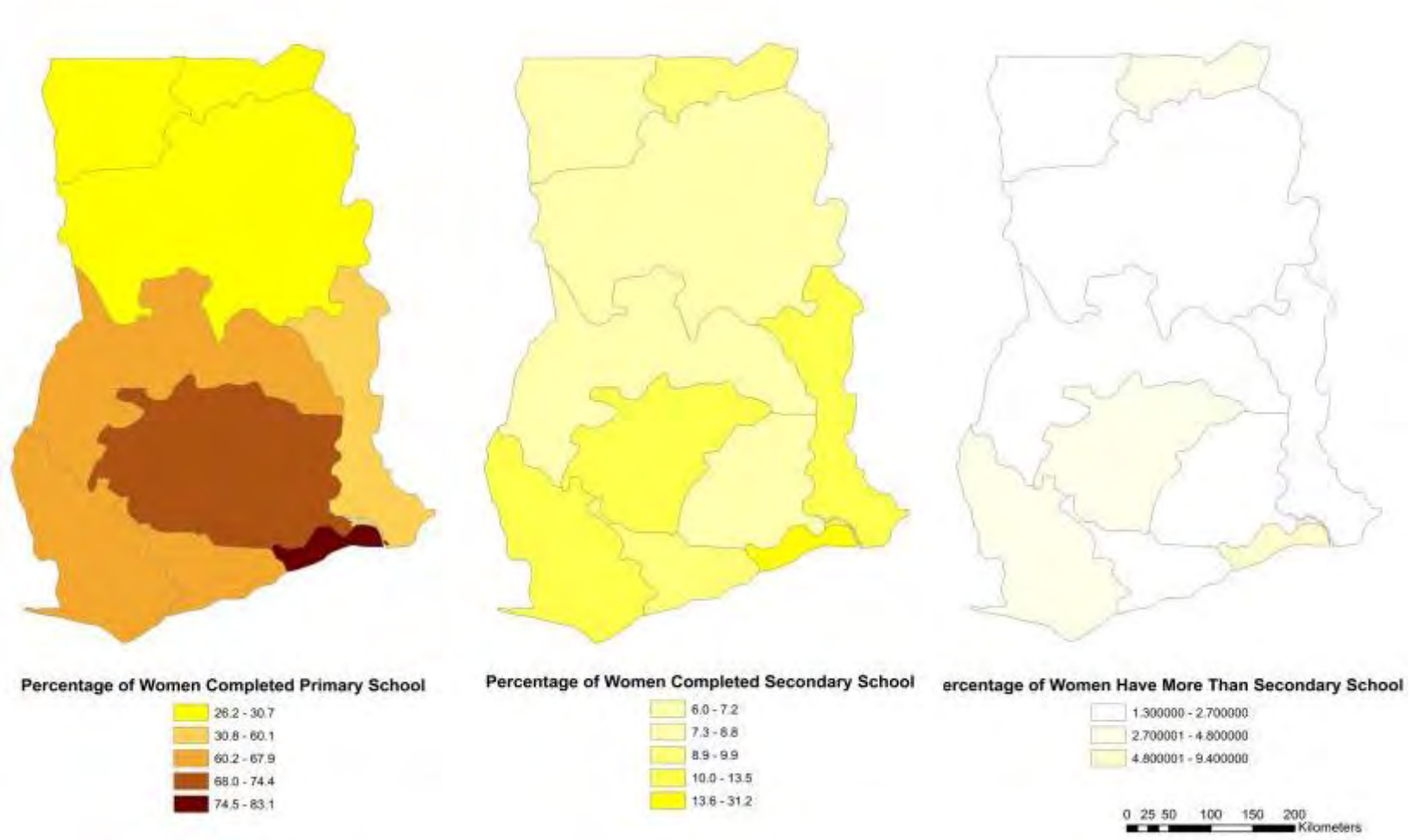
*Data from Ghanainfo.gov.gh Type indicator: Under Poverty".
(detailed data can be found at the author's thesis)

EDUCATION IN MEN



*Data from Ghana Statistical Service – Demographic and Health Survey, 2009
(detailed data can be found at the author's thesis)

EDUCATION IN WOMEN



*Data from Ghana Statistical Service – Demographic and Health Survey, 2009
(detailed data can be found at the author's thesis)

ACCESS MEASURE

Reference: Howard and Bartram, 2003

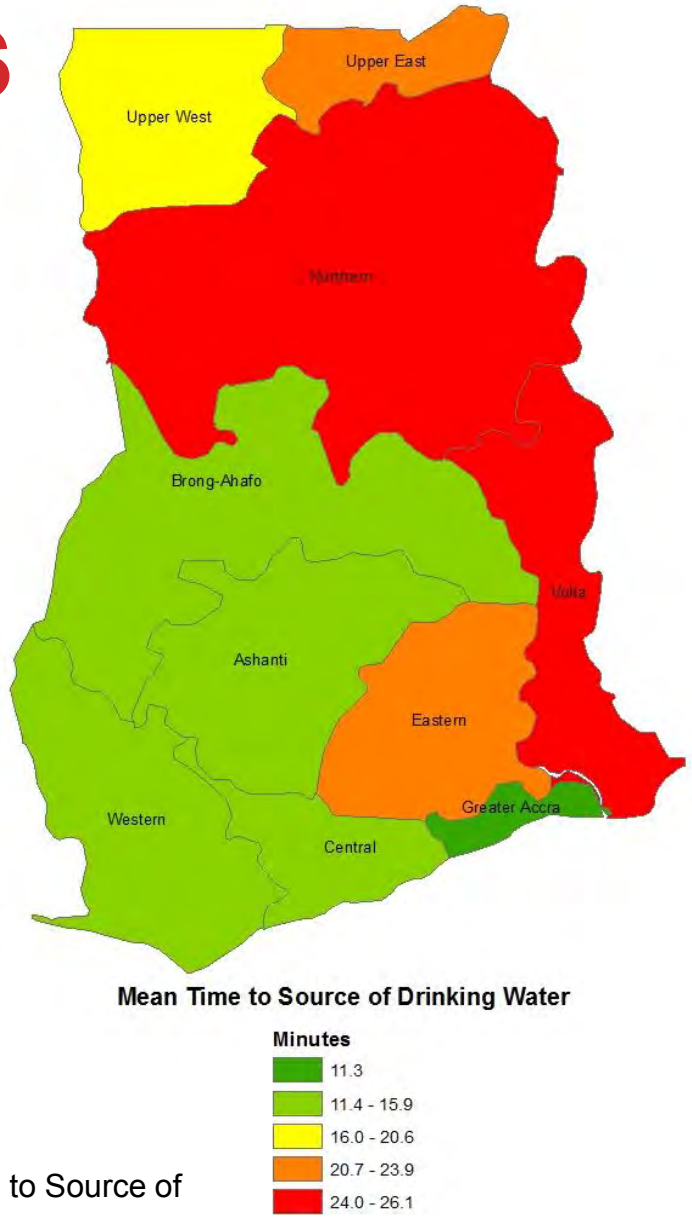
Service level	**Access measure**	*Needs met*	**Level of health concern**
No access (quantity collected often below 5 l/c/d)	More than 1000m or 30 minutes total collection time	Consumption – cannot be assured Hygiene – not possible (unless practised at source)	Very high
Basic access (average quantity unlikely to exceed 20 l/c/d)	Between 100 and 1000m or 5 to 30 minutes total collection time	Consumption – should be assured Hygiene – handwashing and basic food hygiene possible; laundry/ bathing difficult to assure unless carried out at source	High
Intermediate access (average quantity about 50 l/c/d)	Water delivered through one tap on-plot (or within 100m or 5 minutes total collection time	Consumption – assured Hygiene – all basic personal and food hygiene assured; laundry and bathing should also be assured	Low
Optimal access (average quantity 100 l/c/d and above)	Water supplied through multiple taps continuously	Consumption – all needs met Hygiene – all needs should be met	Very low

WATER RESOURCES

Access measure: between 100 and 1000m or 5 to 30 minutes total collection time = BASIC ACCESS

(Howard and Bartram, 2003)

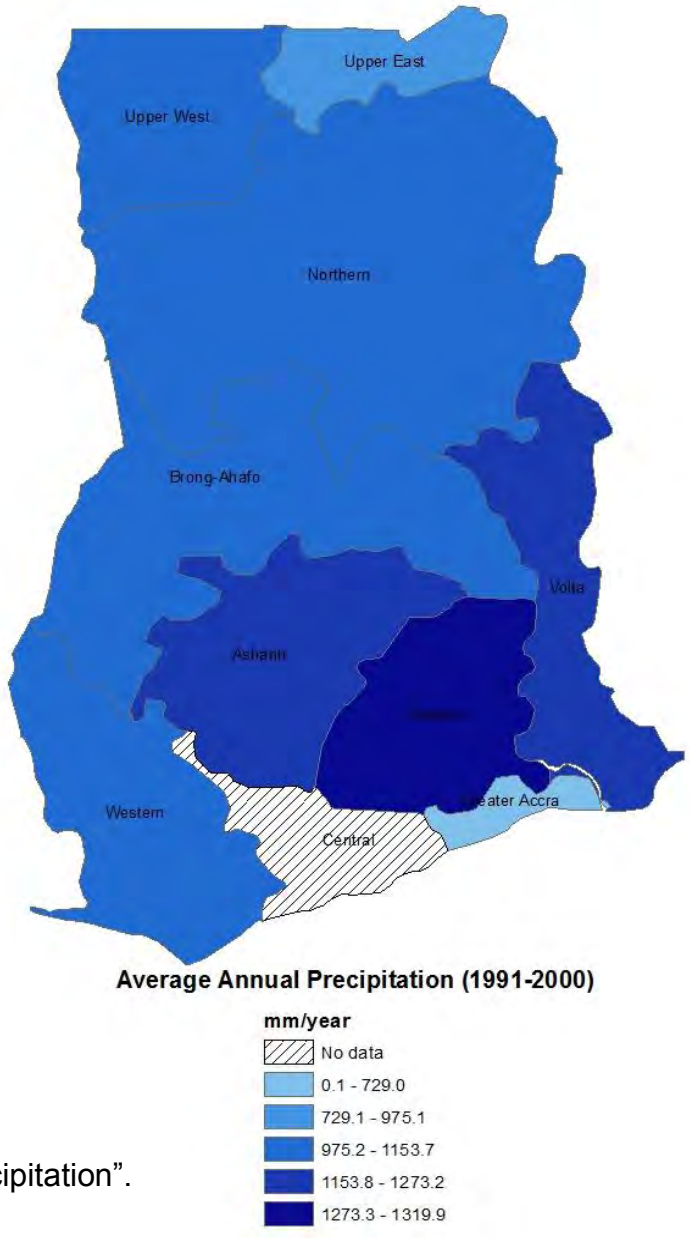
- **ALL regions in Ghana only reach the BASIC ACCESS level**



*Data from Ghanainfo.gov.gh Type indicator: drinking water, choose “Mean Time to Source of Drinking Water”. (detailed data can be found at the author’s thesis)

PRECIPITATION

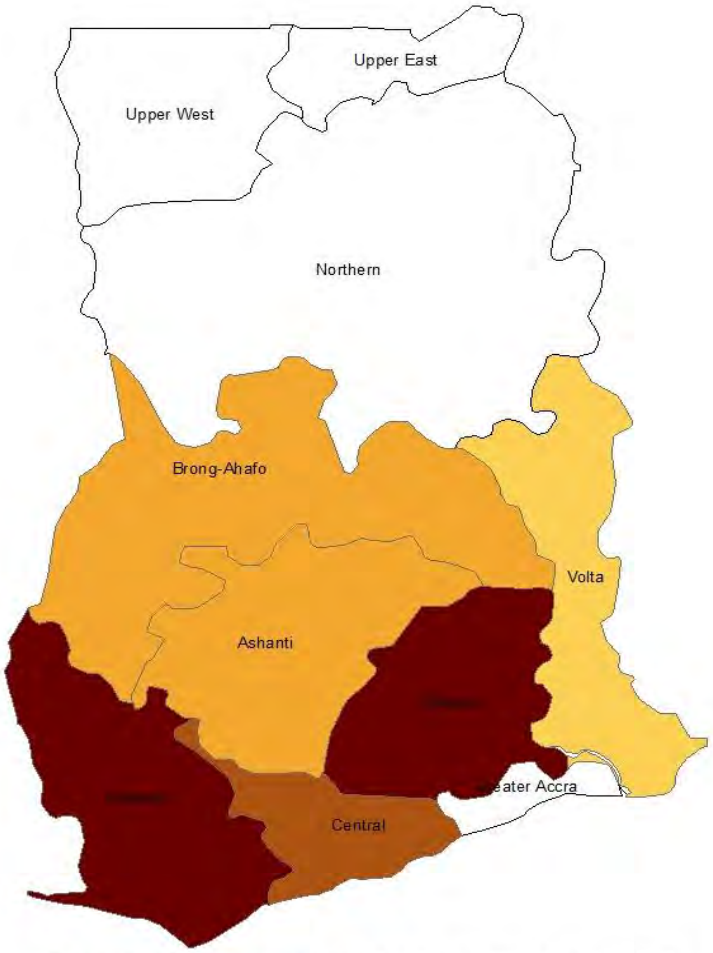
- **Precipitation varies from 700mm to 1300mm.**
- **Max: Eastern Region**



*Data from Ghanainfo.gov.gh Type indicator: drinking water, choose “Annual Precipitation”. (detailed data can be found at the author’s thesis)

OIL PALM

- **Only suitable for 6 regions:**
  - Western Region
  - Eastern Region
  - Central Region
  - Ashanti Region
  - Brong-Ahafo Region
  - Volta Region

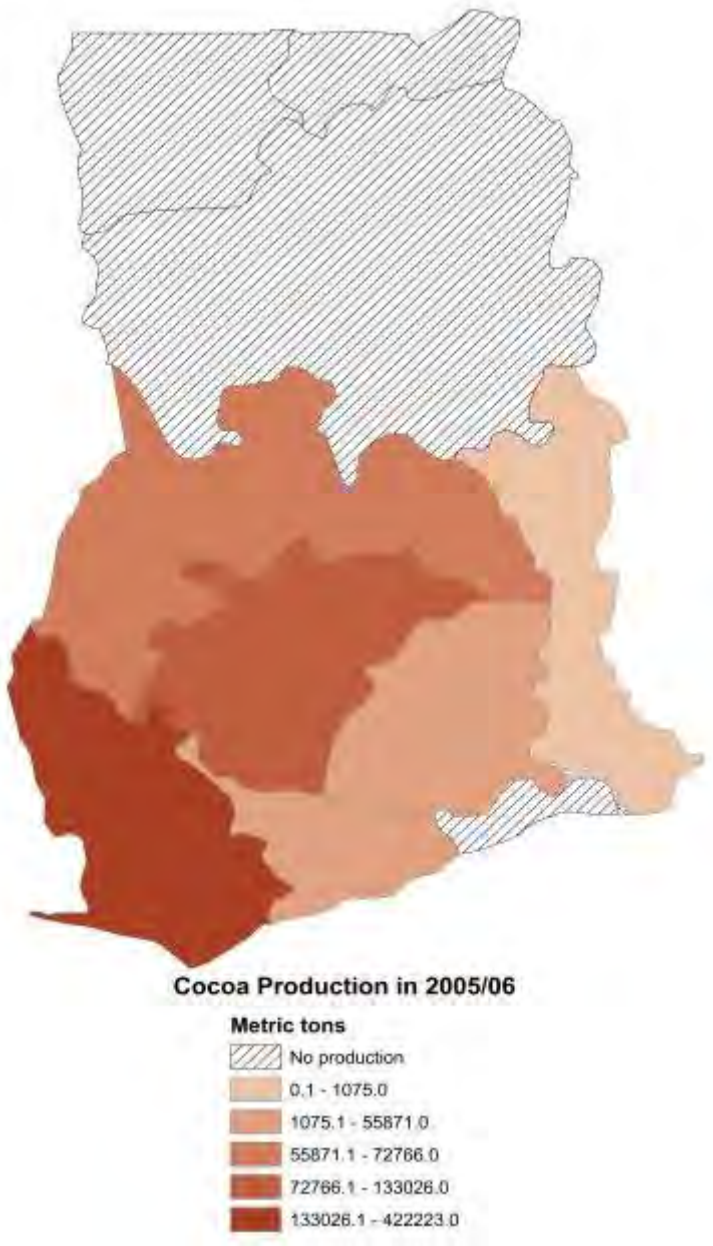


Proportion of area under oil palm cultivation in 2010

*Data from MASDAR Consulting Team 2011. Online available at: http://mofa.gov.gh/site/?page_id=10244 (detailed data can be found at the author's thesis)

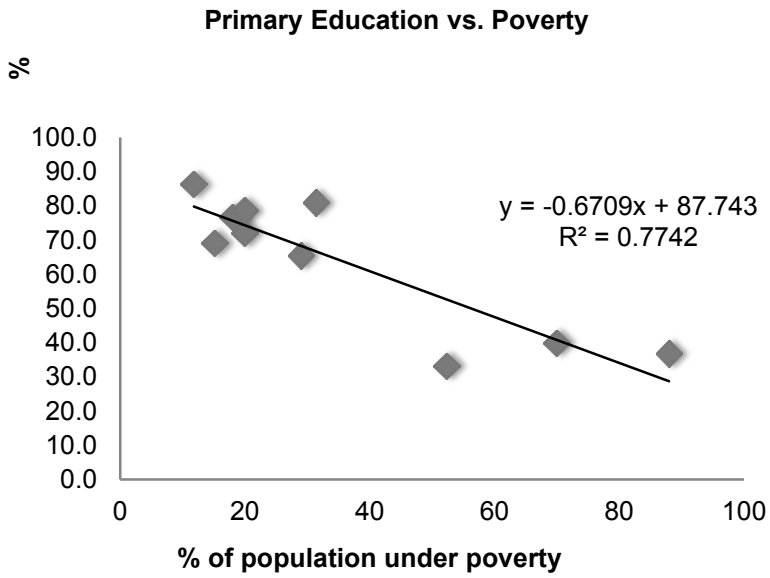
COCOA

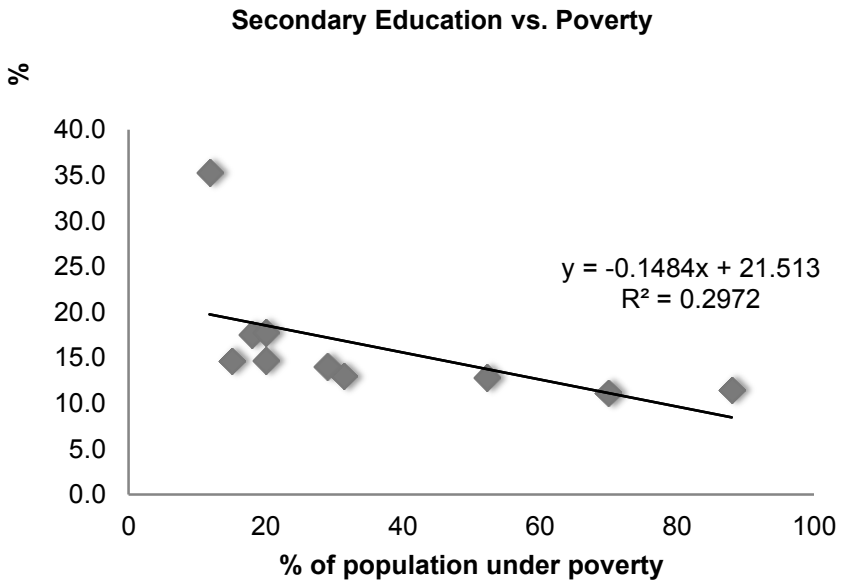
- **Only suitable for 6 regions:**
  - Western Region
  - Eastern Region
  - Central Region
  - Ashanti Region
  - Brong-Ahafo Region
  - Volta Region



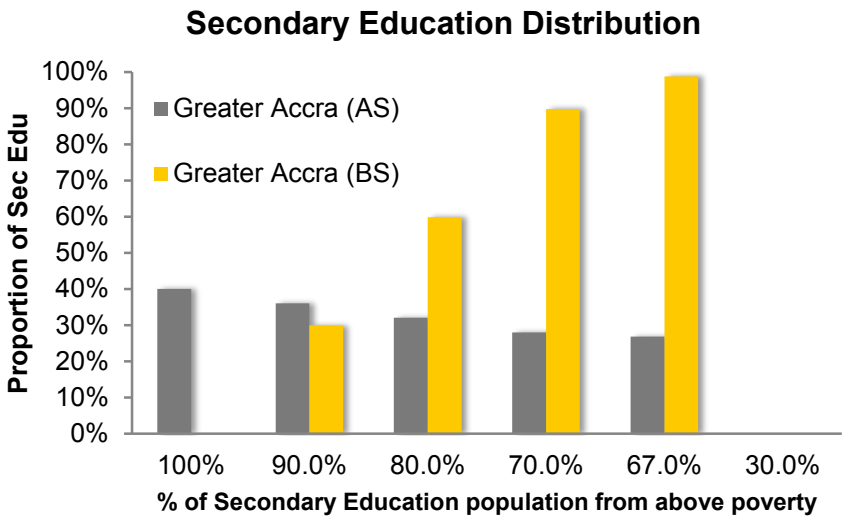
*Data from Ghana Cocoa Board: Economic Actvities
(detailed data can be found at the author's thesis)

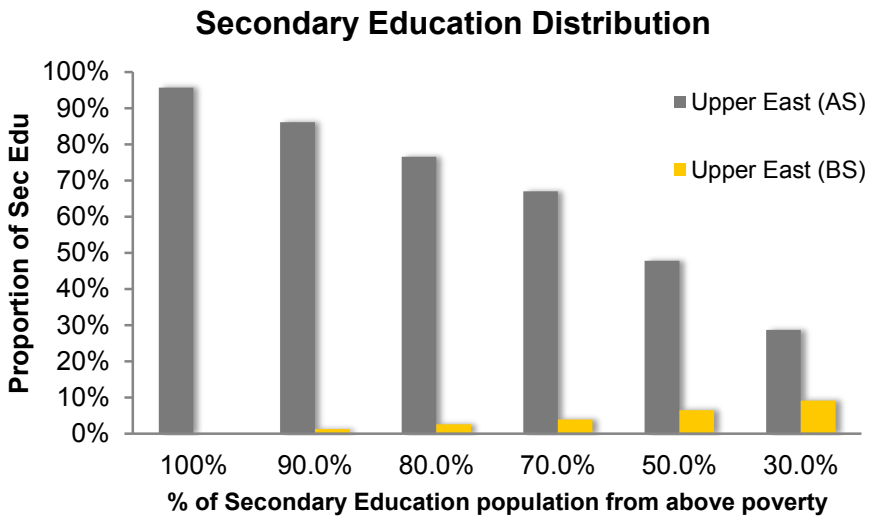
EDUCATION VS. POVERTY



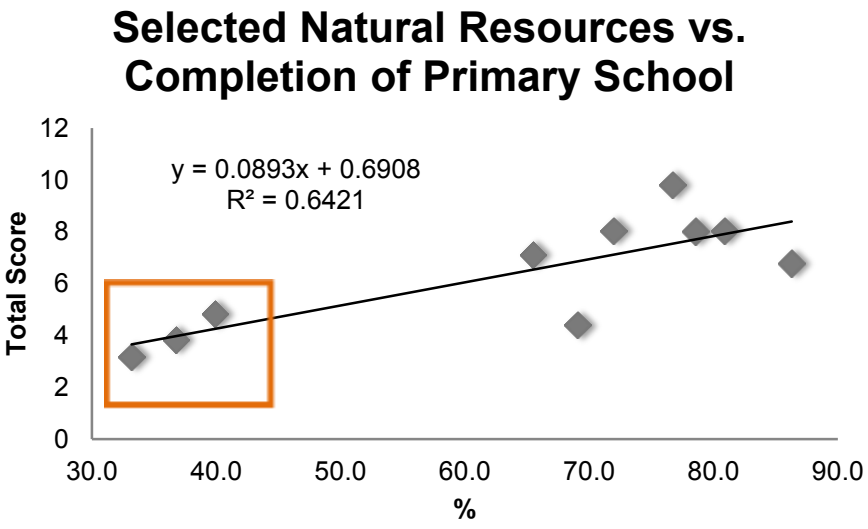


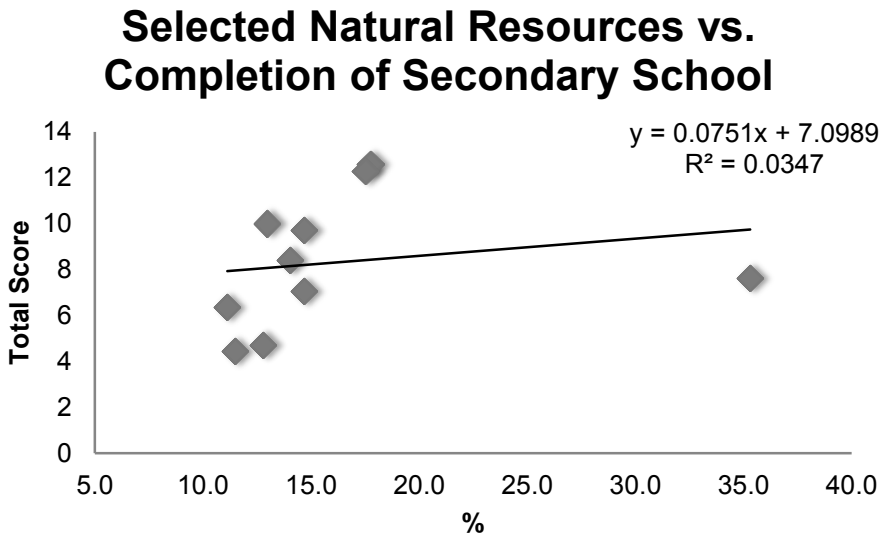
EDUCATION DISTRIBUTION



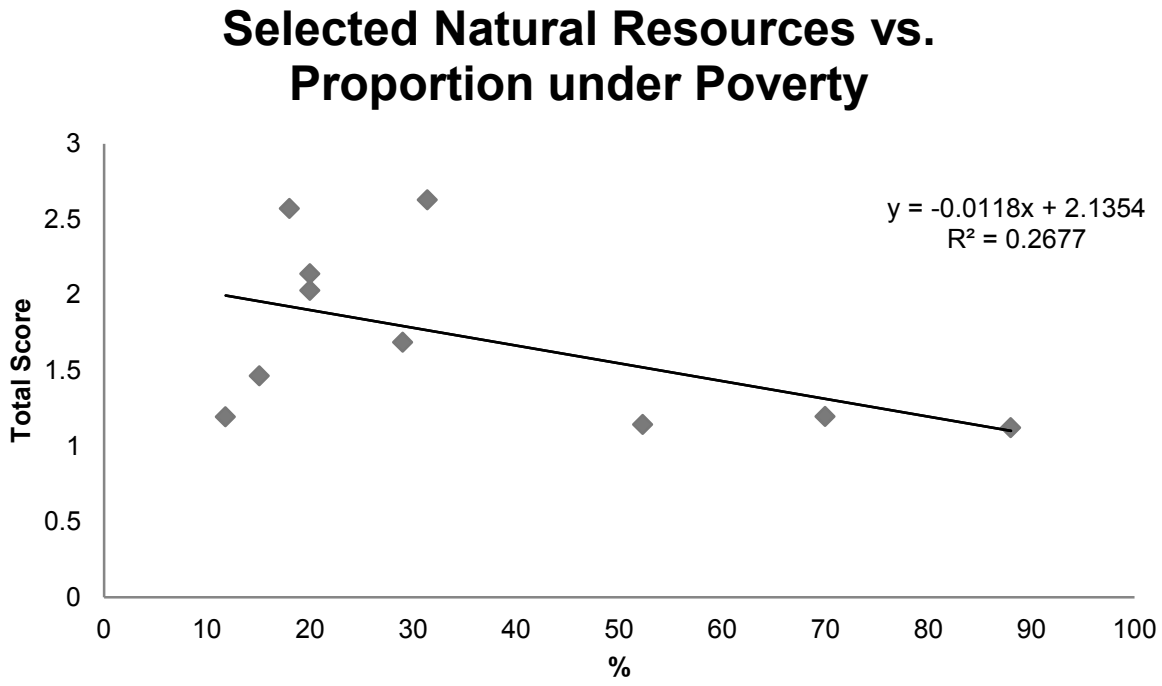


NATURAL RESOURCES VS. EDUCATION



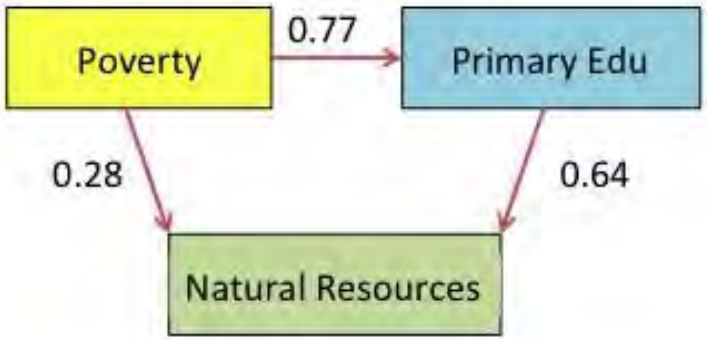


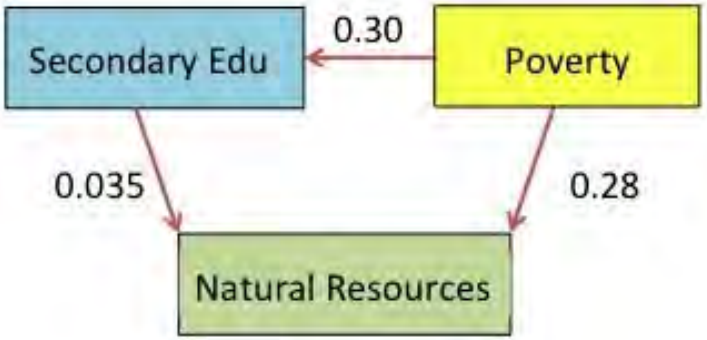
NATURAL RESOURCES VS. ECONOMICS



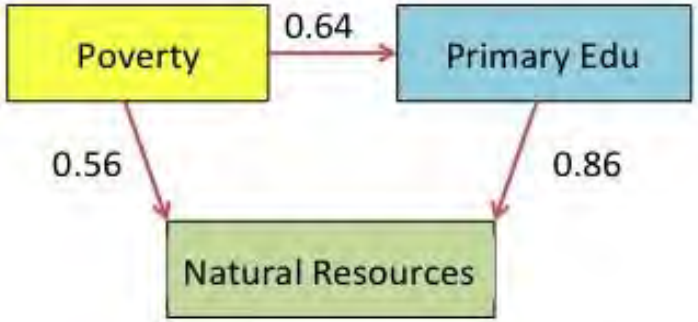
ECONOMICS, EDUCATION & NATURAL RESOURCES

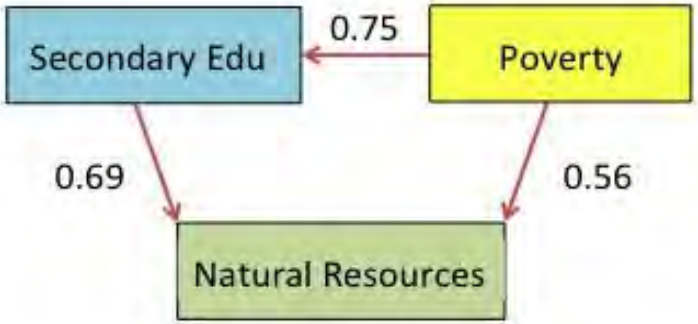
Correlation between three indicators with Greater Accra





Correlation between three indicators without Greater Accra





AREA RECOMMENDATION

- **Three areas:**
  - Area I – Greater Accra
  - Area II – Western, Central, Eastern, Ashanti, Brong Ahafo and Volta Regions
  - Area III – Northern Sector: Upper East, Upper West and Northern Regions

AREA RECOMMENDATION

- **Area I:**
  - Improve living standards of population, especially those with higher education.
- **Area II:**
  - Improve agricultural technology to achieve higher yield and practicing sustainable natural resources management.
- **Area III:**
  - Put the focus on education (primary and secondary) to strengthen labor force for utilization of undiscovered natural or human resources

PART II
CASE STUDY ON CUSTOMERS' PREFERENCES FOR HOUSEHOLD WATER TREATMENT & SAFE STORAGE PRODUCTS

GHANA WATER

JMP - estimated trends of drinking water coverage

Ghana	Drinking water coverage estimates					
	Urban (%)		Rural (%)		Total (%)	
	1990	2010	1990	2010	1990	2010
Piped onto premises	41	33	2	3	16	18
Other improved source	43	58	34	77	37	68
Other unimproved	7	9	11	9	10	9
Surface water	9	0	53	11	37	5
	100	100	100	100	100	100

Source: WHO/UNICEF JMP, 2012

WATER REALITY

- Yet 3.6 million population does not have access to improved drinking water in Ghana

- Improved drinking water

≠

Safe drinking water

GHANA WATER MARKET

- **Direct water supply (McGranahan et al, 2006)**
  - Ghana Water Company (GWC)
  - Tanker operators
  - Cart operators
  - Domestic vendors
  - Neighborhood sellers
  - Sachet water/ice block sellers
- **Indirect water supply and treatment**

Picture from David and Ruth Snyder

Picture from Community Water Solution

HWTS PRODUCTS

- **HWTS Products (Murcott, 2007)**
  - Safe Storage
  - Disinfection including boiling, chlorination and UV disinfection
  - Particle Removal technologies (ceramic filter)
  - Combined system, i.e., coagulation & chlorine disinfection (PuR)
  - Chemical removal system

HWTS MARKET

- **Chlorine disinfectant/chemical removal: *Aquatab***
  - Ingredient: NaDCC
  - Emergency usage, 13 million daily users
  - Currently available in Ghana
- **Particle removal: *CrystalPuR, Kosim Series, Life Straw***
  - Ingredient: Clay, Rice Husk
  - Subsidized and donated by organizations
  - Currently available in Ghana
- **Combined treatment: *PuR***
  - Ingredient: $Ca(ClO)_2$, $Fe_2(SO_4)_3$
  - Subsidized by P&G, emergency usage
  - Currently not available in Ghana

HWTS SUSTAINABLE?

- ***PuR:*** **22 out of 514 households repeat using PuR after 6 months of marketing in Guatemala**

- ***LifeStraw*****: "straw that saves life" (*****New York Times*****), 13% usage of the device among over 300 household in Ethiopia after two weeks of distribution**

- ***Kosim Filter*****:46% were using it one year after the sale period in Tamale, Ghana**

OBJECTIVE: MARKET & CUSTOMER PREFERENCE

- What are customer preference when they are given a choice?
- What can be improved to increase market share and correct, consistent and sustainable use?

METHODOLOGY

- **Literature review**
  - Products distributed in developing countries (Kenya, Ethiopia, Vietnam, etc.)
  - Market research conducted for HWTS in different regions
- **Our research**
  - Interviews
  - Observation
  - Analysis

METHODOLOGY

- **Literature review**
  - Correct, consistent and sustainable use is low
  - Subsidy dominant (Diageo Foundation, USAID, P&G)
  - People are not given a choice

METHODOLOGY

- **Literature review**
  - Correct, consistent and sustainable use is low
  - Subsidy dominant (Diageo Foundation, USAID, P&G)
  - People are not given a choice
- **Products selection**
  - Chemical removal: *Aquatab*
  - Particle removal: *Kosim Series, LifeStraw, CrystalPuR*
  - Combined system: *PuR*

METHODOLOGY

Products selected (chemical removal, physical removal & mixed system)

METHODOLOGY

	Cost (GHC)	Lifespan	Flow rate (m^3)	Price/Volume (GHC/m^3)
Piped Water	0.478/m^3	N/A	TBD	0.48
Kosim Deluxe	75	2 yrs +	6-9 L/hr	0.86
Kosim Classic	45	2 yrs +	1-3 L/hr	2.57
CrystalPur	20	3-6 months	4-6 L/hr	2.86
Tank Water	2.942/m^3	N/A	N/A	2.94
Life Straw Family	60	3 yrs	6 L/hr[1]	3.33
Aquatab	0.5/tablet	One time use	N/A	50.00
PuR	5/packet	One time use	N/A	500.00

1. One inch diameter pipe
2. All prices are determined by PHW's consultant Jim Niquette and Weini Qiu

METHODOLOGY

- ## Question survey

1. Where do you live in Tamale?	2. What water source do you drink at home?	3. Are you the purchasing decision maker at home?
1. Rural 2. Peri-urban 3. Urban 4. Others _____	1. Tap Water 2. Dugout Water 3. Others_____________ 4. Sachet & Bottled Water 5. Do not have water supply	1. Always 2. Often but not always 3. Sometimes 4. Never, then who_____?

Thank you very much for doing the survey! **Please answer these following questions. And we have prepared a small gift for you at the end.** **Don't forget to ask me!**	 ***Ko***[illegible] can improve drinking water quality and treat 4-6 Liter of water per hour. It has its safe storage bucket equipped and great for rural family.	 ***CrystalPur*** is a water filter device removes most of the bad bacteria. It is small and does not require a lot of maintenance. It filters 4-5 liter per hour.	 ***PuR*** is chemical powder that disinfects water. Each packet treats 10 liters of water. It is perfect for treating water with less dirt.	 ***Life Straw*** filters 10 liter of dirty water per hour and does not occupy land space at home. It removes bacteria fast without chemical. It is easy for children to use.	 ***Aquatabs*** is a tablet that removes bad bacteria with mixed alum and chlorine. One tablet treats 10 liters of water and is convenient to carry around for treating various type of water.	 ***Kosim Deluxe*** is designed for people require high quality of water and life style. It removes almost 100% dirt and bad bacteria in tap water. It is a great device for offices.
Which one would you prefer to buy? (Please rank Top 1, 2 & 3)						
What concern you the most in this product? (Size, volume, water quality, appearance, maintenance, etc.)						
Is the product enough to treat water you and your family drink per day? (Yes or No)						
The price is listed now. Would you like to buy this product? Please rank Top 1, 2&3 :)	1. Yes! The price is OK. Rank __________ 2. I will NEVER buy. Why _________?	1. Yes! The price is OK. Rank __________ 2. I will NEVER buy. Why _________?	1. Yes! The price is OK. Rank __________ 2. I will NEVER buy. Why _________?	1. Yes! The price is OK. Rank __________ 2. I will NEVER buy. Why _________?	1. Yes! The price is OK. Rank __________ 2. I will NEVER buy. Why _________?	1. Yes! The price is OK. Rank __________ 2. I will NEVER buy. Why _________?
Where would you prefer to buy this product?	1. In fixed location such as this shop 2. Supermarket 3. In shops that I see everywhere (e.g., drink shop) 4. From village volunteers	1. In fixed location such as this shop 2. Supermarket 3. In shops that I see everywhere (e.g., drink shop) 4. From village volunteers	1. In fixed location such as this shop 2. Supermarket 3. In shops that I see everywhere (e.g., drink shop) 4. From village volunteers	1. In fixed location such as this shop 2. Supermarket 3. In shops that I see everywhere (e.g., drink shop) 4. From village volunteers	1. In fixed location such as this shop 2. Supermarket 3. In shops that I see everywhere (e.g., drink shop) 4. From village volunteers	1. In fixed location such as this shop 2. Supermarket 3. In shops that I see everywhere (e.g., drink shop) 4. From village volunteers

DEMOGRAPHY

- Locations
- Decision maker at home
- Number of people in the household
- Occupation

PRODUCT QUESTIONS

- Amount of water needed
- Ranking of products
- Reasons of choice
- Distribution

PRODUCTS COMPARISON

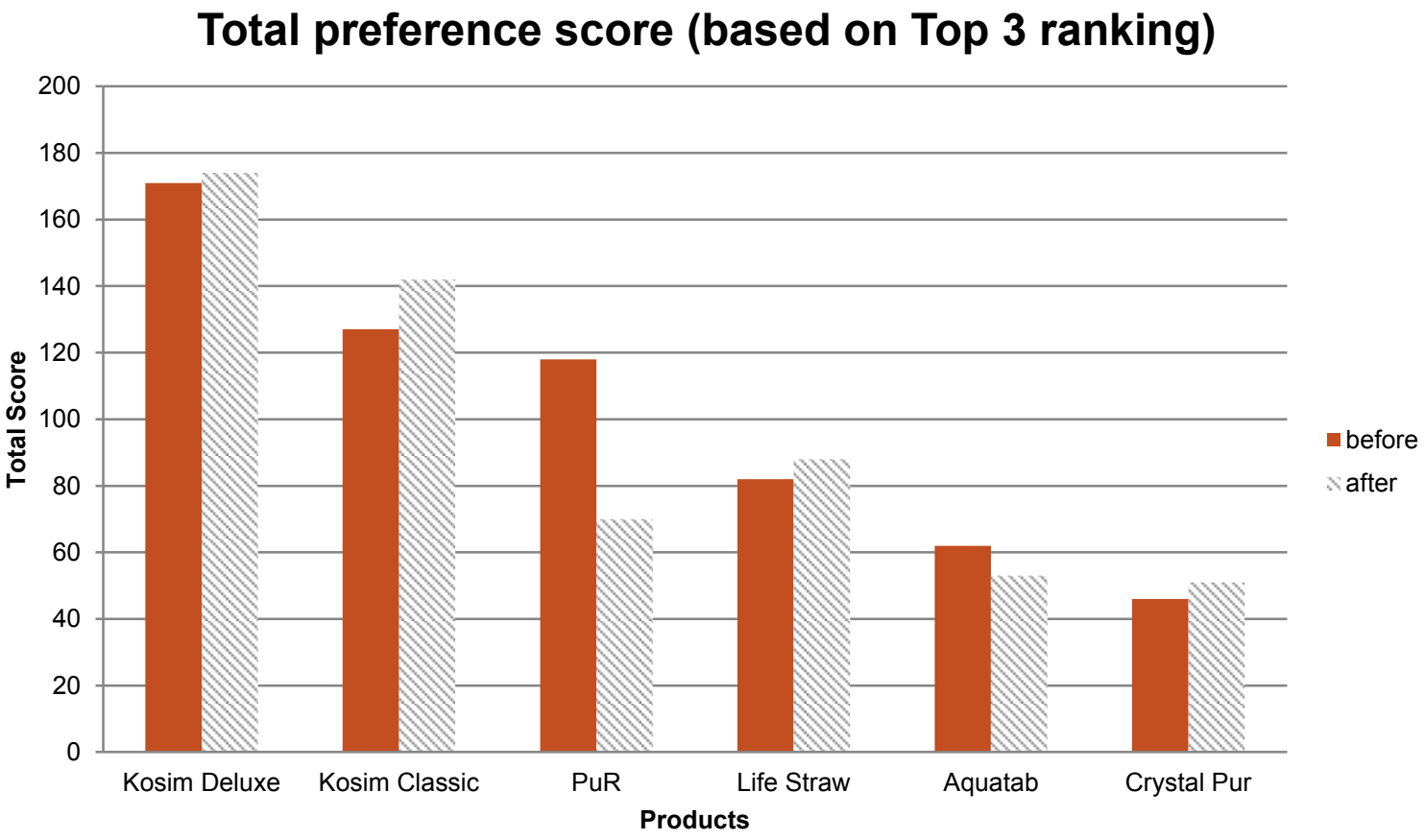
- **Top three choices customers prefer (BEFORE price announced):**
  - 1. *Kosim Deluxe*
  - *2. Kosim Classic*
  - 3. PuR

- **Top three choices customers prefer (AFTER price announced):**
  - 1. *Kosim Deluxe*
  - *2. Kosim Classic*
  - 3. Life Straw

PRODUCTS COMPARISON

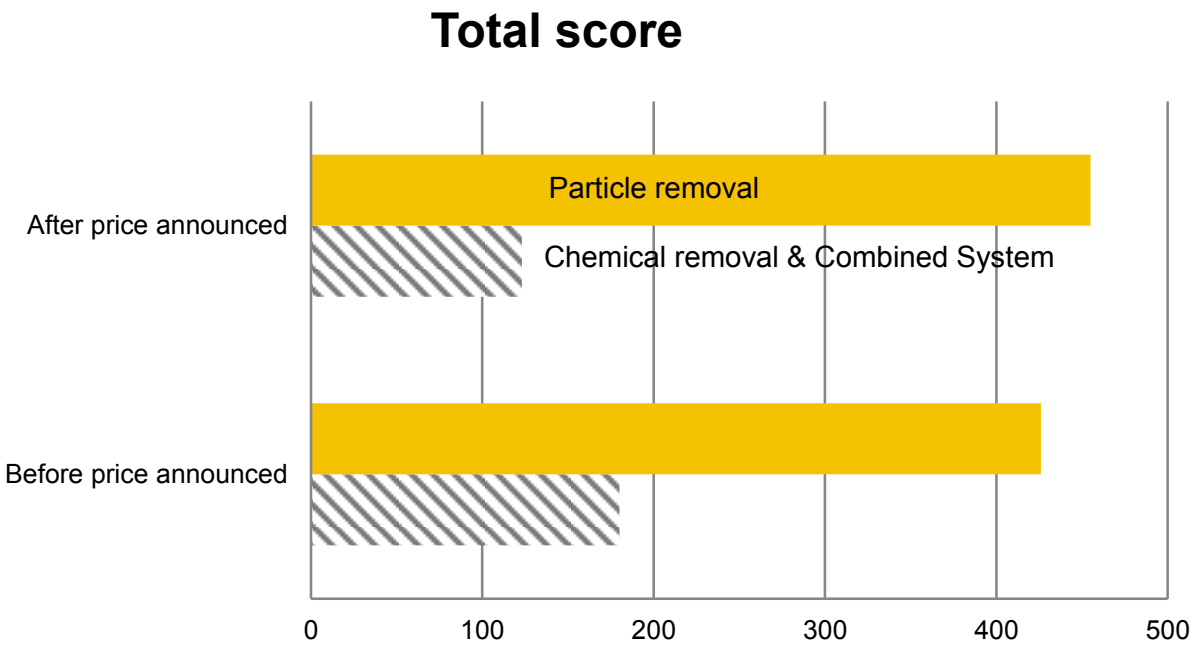
- **Top three choices customers prefer (BEFORE price announced):**
  - 1. *Kosim Deluxe*
  - *2. Kosim Classic*
  - 3. PuR
- **Top three choices customers prefer (AFTER price announced):**
  - 1. *Kosim Deluxe*
  - *2. Kosim Classic*
  - 3. Life Straw

PRODUCTS COMPARISON



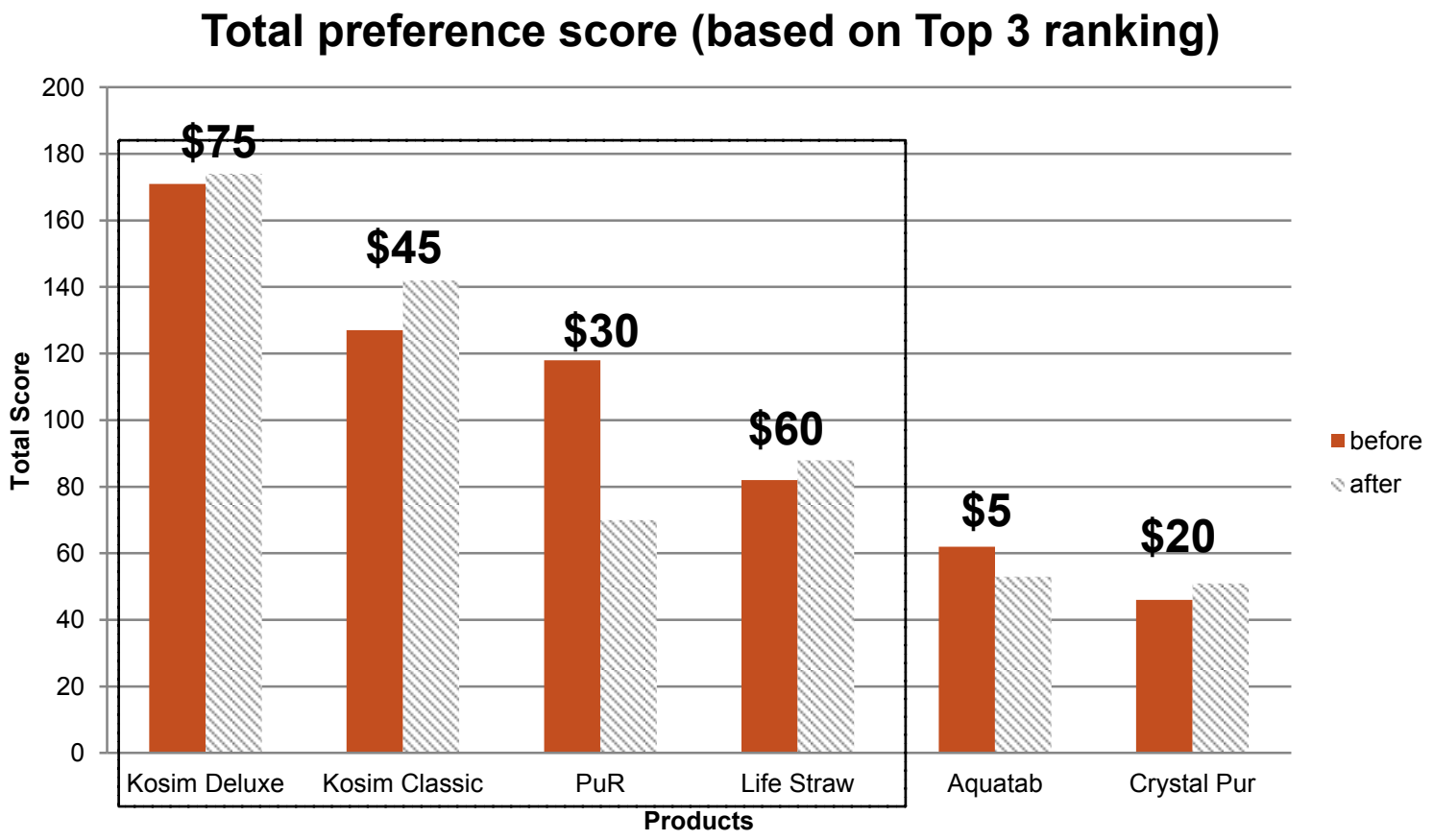
PHYSICAL VS. CHEMICAL

- **Particle removal products seem more attractive**



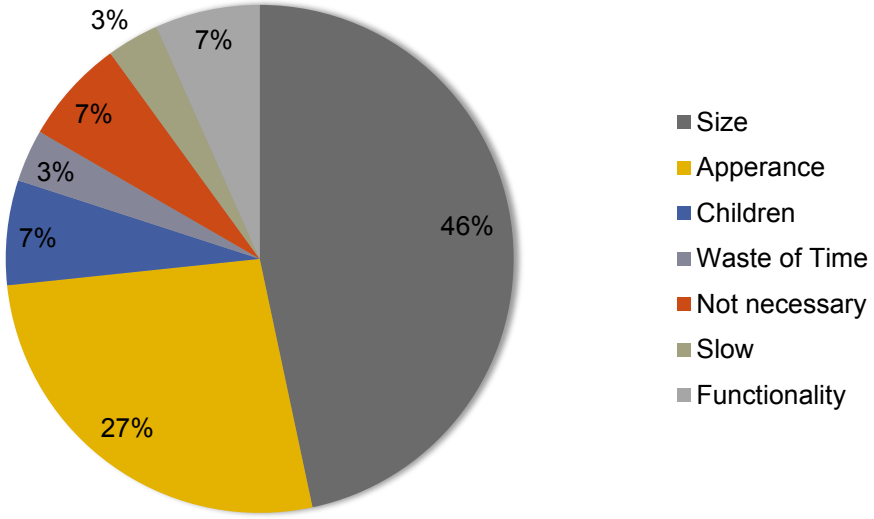
PRICE

- Higher price suggests better performance

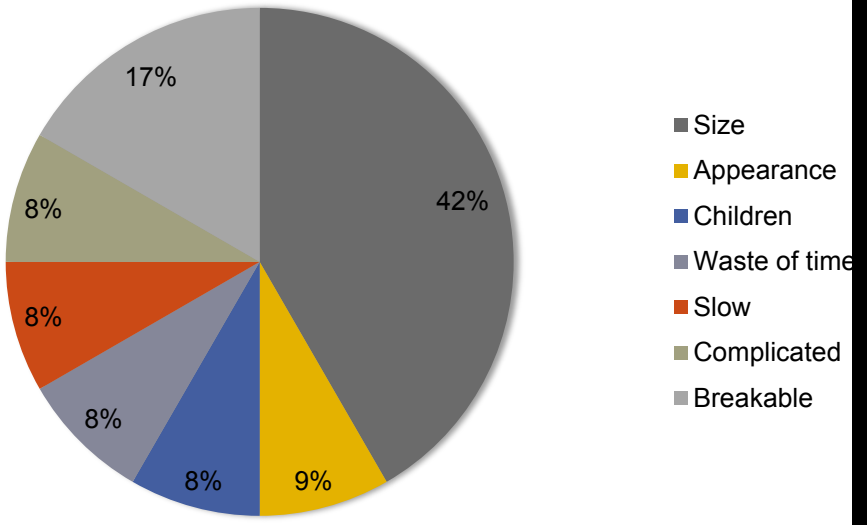


OTHER FACTORS

Kosim Classic

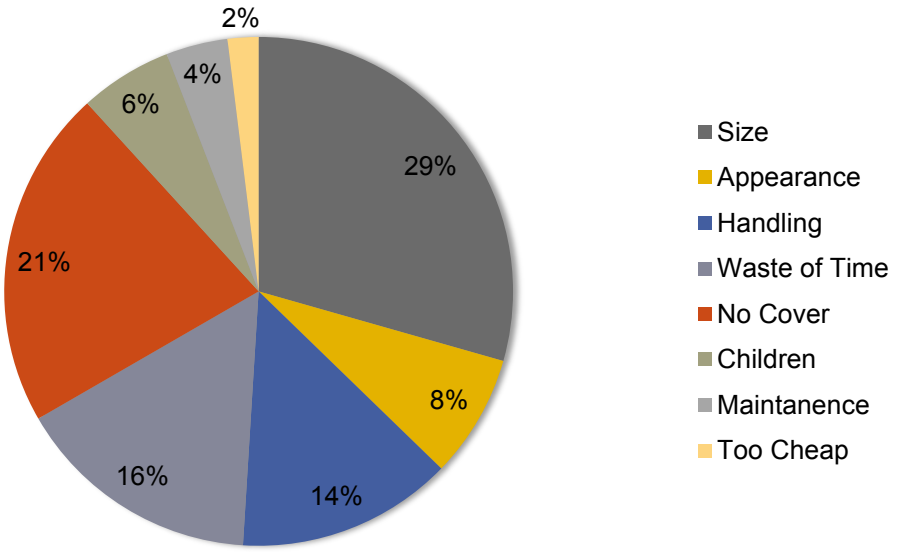


Kosim Deluxe

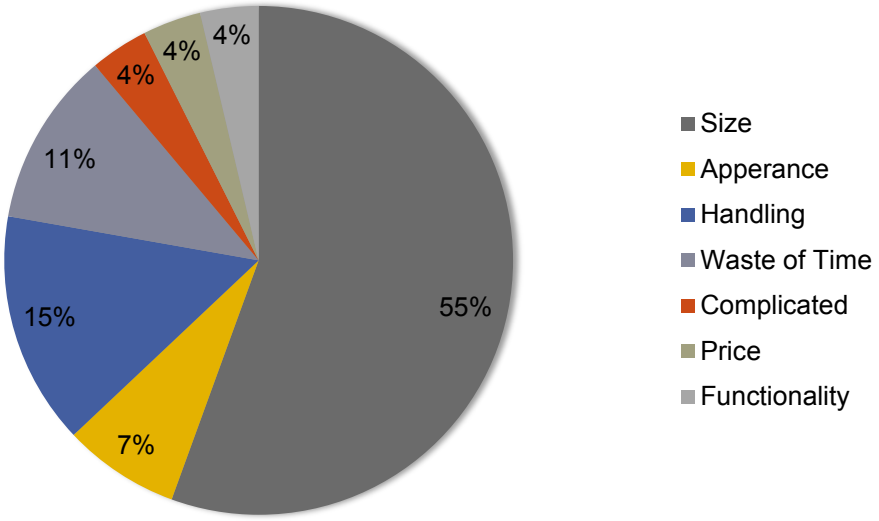


OTHER FACTORS

CrystalPur

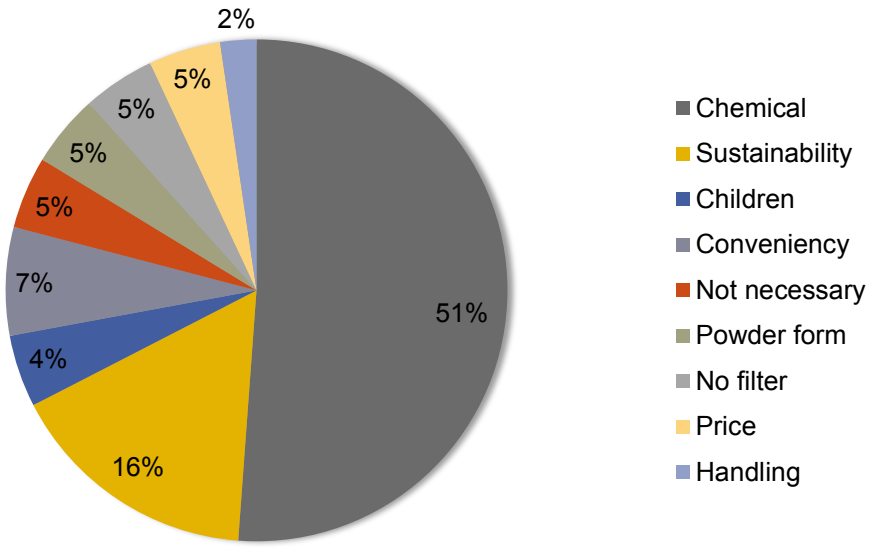


Life Straw

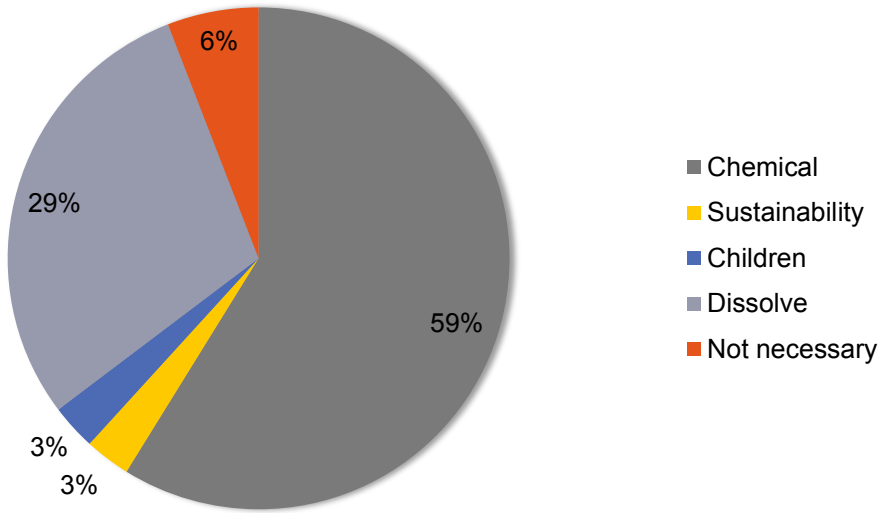


OTHER FACTORS

PuR



Aquatabs



RECOMMENDATION & CONCLUSION

- **Economics, Education and Selected Natural Resources are correlated (moderate to strong)**
- **Respondents show more interest to buy HWTS products if:**
  - Prices between GHC 18 to GHC 45;
  - To be sold at a fixed shop and/or trustworthy stores;
  - HWTS should be advertised as “providing luxury water”;
  - Products are suitable size for families and;
  - Have NO chemicals

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