# Productive Use of Domestic Rural Water Systems: The Senegal Case

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# Research Questions

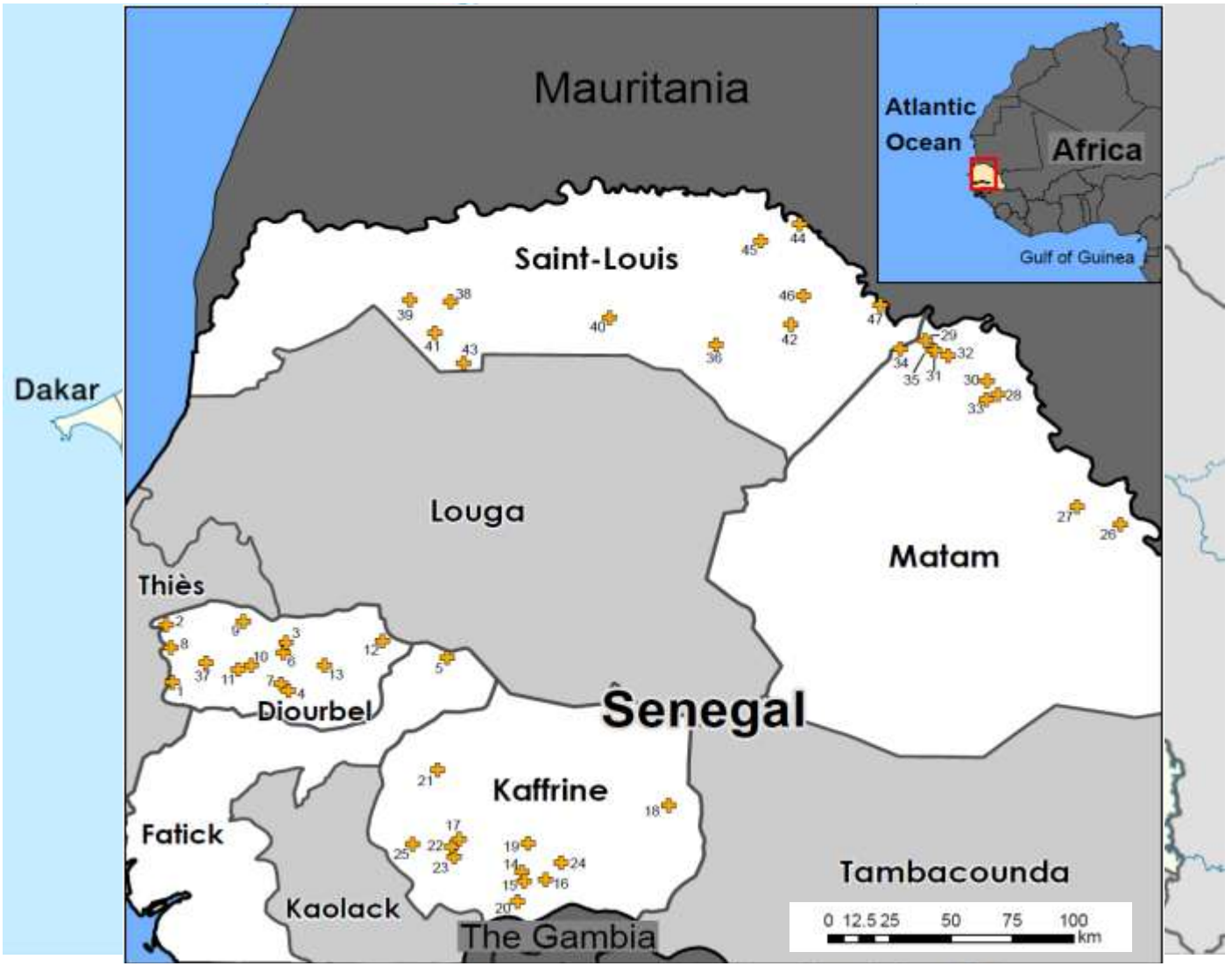
1. To what extent and under what conditions does productive use of domestic piped water occur?

2. What are the incremental costs of, and expected income generated by, upgrading 'basic needs' systems to productive use capacity?

3. What evidence exists regarding the financial/ technical sustainability of piped water systems used for income-generating activities?

4. Who benefits when piped water supply systems are used for productive purposes?

# 47 sites in 4 regions of Senegal

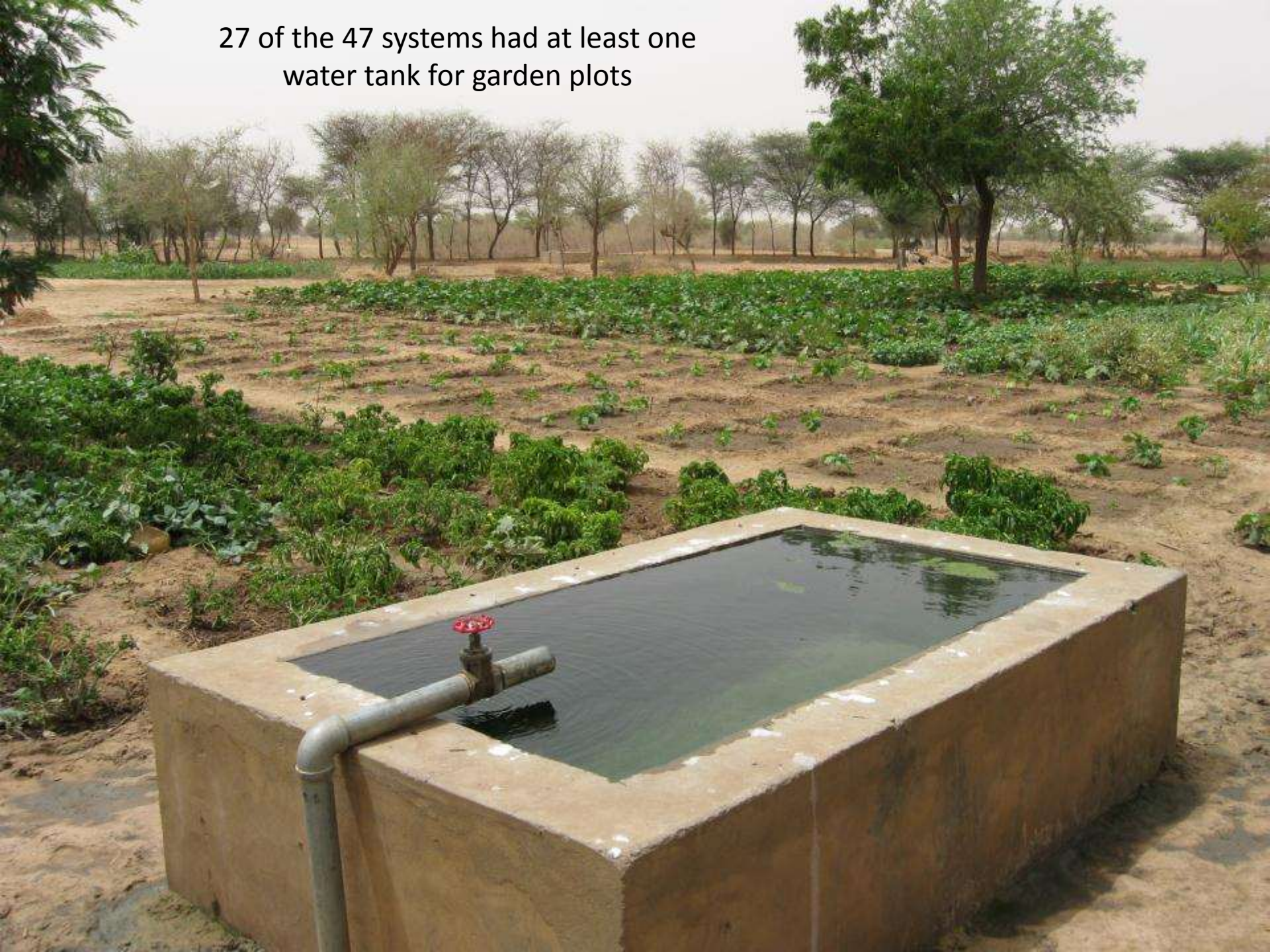


# Important caveats

- Cross-sectional design
- Purposive sampling:
  - Piped water systems
  - Functioning water committees
  - *Ex-ante* estimates of productive activity (*to create treatment group; control group selected from all other systems*)
- *Ex-post* analysis revealed no significant difference between treatment versus control


TOYOTA


GBA 14


27 of the 47 systems had at least one water tank for garden plots

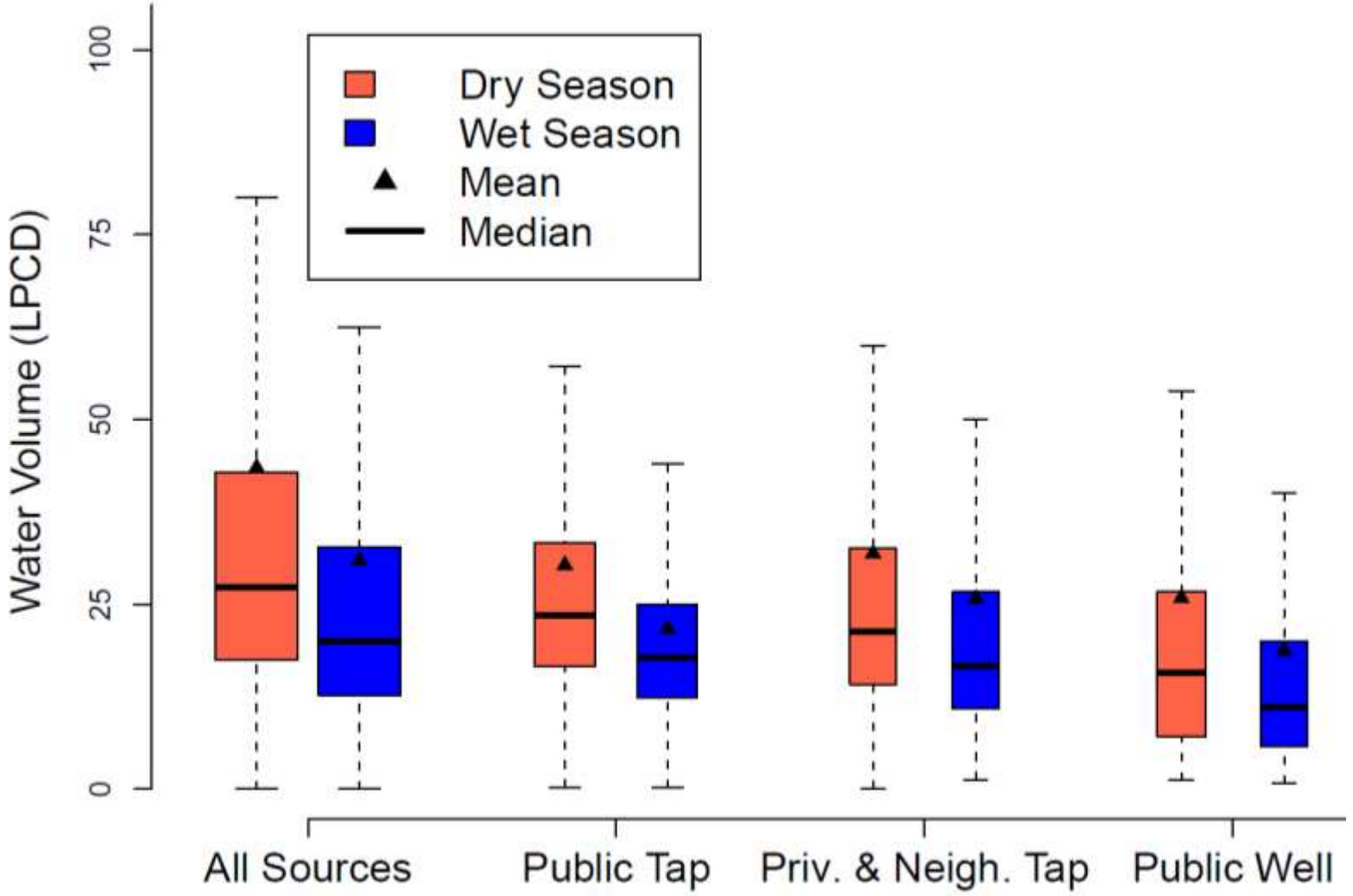
43 of the 47 systems had at least one cattle trough


1-14
15-25
26-31
32-34
35-40
1-22

# Field Research Components

- Household Surveys:  1,860
- Engineering Assessments: 47
- Leader interview:  47
- Water committee interview: 46
- Water operator interview:  44
- Women's Focus groups:  15

# Household Water Consumption (LPCD) varied by Source and Season



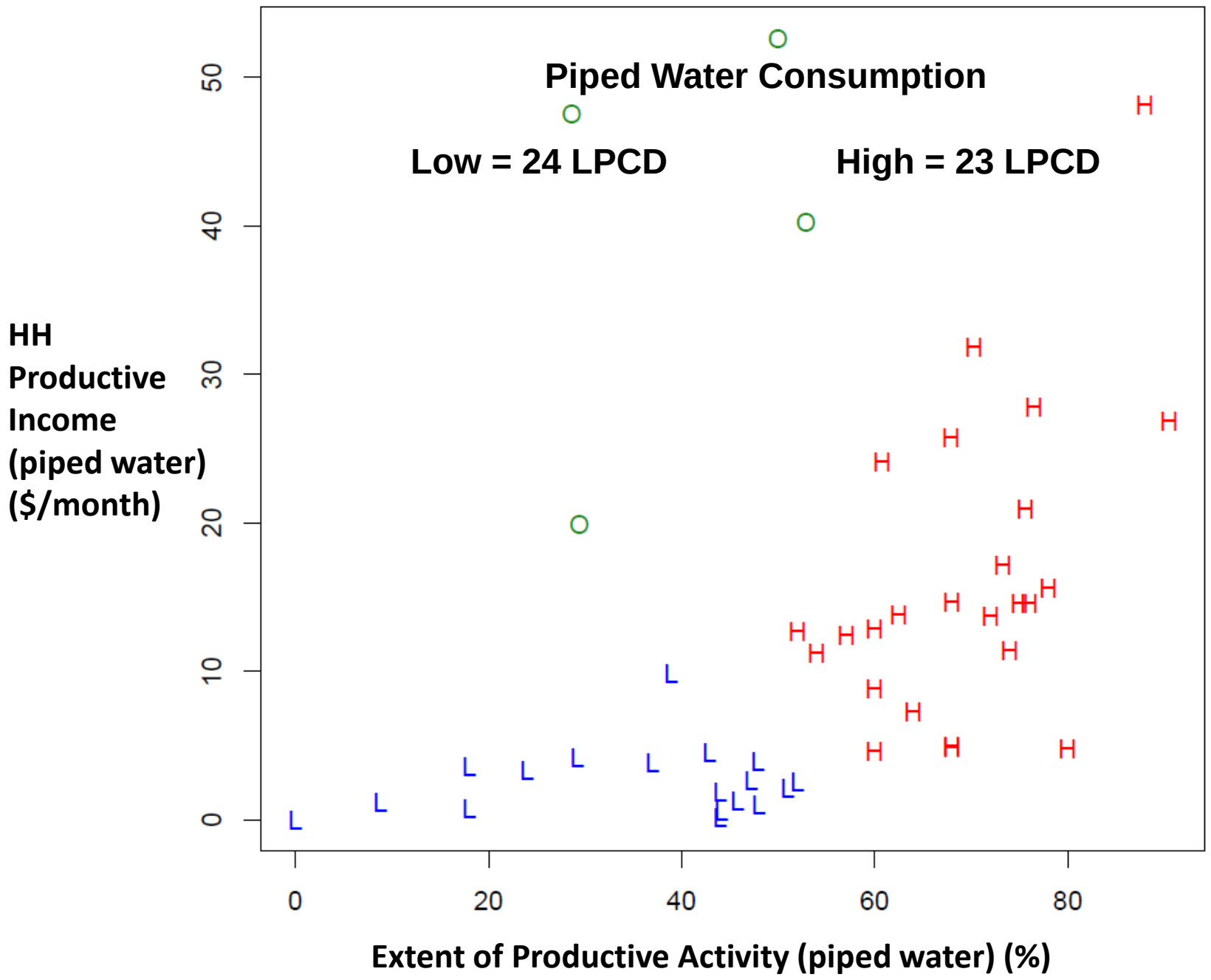

Note: The width of each boxplot provides an indication of the number of households using the water source.

# Systems Classified as High or Low based on 3 variables

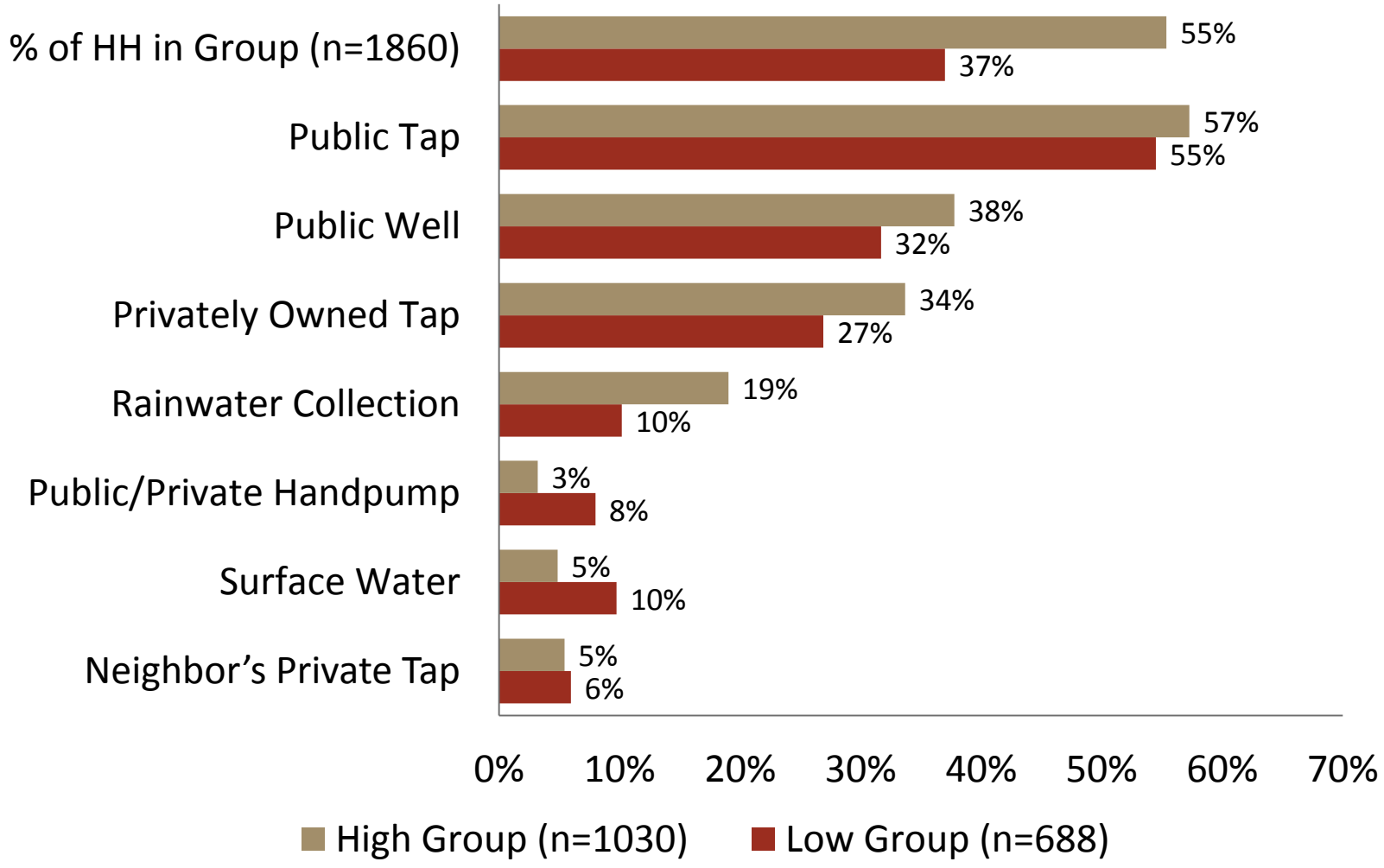
- **Extent of Productive Activity (piped water) (%)**: Percentage of households that undertake (one or more) productive activities that are supported by water from the piped system

- **Household Productive Income (piped water) ($/month)**: Household monthly income (USD) from productive activities that use water from the piped system (90% trimmed means)

- **Piped Water Consumption (LPCD)**: The volume of water (LPCD) used by households from the piped system (90% trimmed means)


Piped Water Consumption
Low = 24 LPCD
High = 23 LPCD
HH Productive Income (piped water) ($/month)
0
10
20
30
40
50
0
20
40
60
80
Extent of Productive Activity (piped water) (%)

# Percentage of Households Using Each Water Source (multiple responses permitted) by Group



# Research Question 1

To what extent and under what conditions does productive use of domestic piped water occur?

# Extent of Household Participation in Productive Activities and the Reliance Upon Water

| Productive Activities | % of HHs participating in activity (n=1860) | % of HHs using any water source for activity (n=1860) | % of HHs using the piped water system for activity (n=1860) |
|---|---|---|---|
| **1 or more productive activities** | **97** | **73** | **54** |
| **Agriculture** | **84** | 4 | 1 |
| **Livestock** | **69** | **69** | **50** |
| **Commerce** | 33 | 5 | 4 |
| **Gardening** | 8 | 6 | 4 |

# Systems with "High" Piped-Water Use are Associated with:

**Water-service related:**

- ↑ Greater # of duties undertaken by water committee
- ↑ More experienced water system operators
- ↑ Greater % of HHs making upfront cash contributions for system construction
- ↑ Greater likelihood that community initiated construction of water system

**Non-water-service related:**

- ↑ Greater HH wealth
- ↑ Greater % of HHs receiving remittances
- ↑ Greater % of HHs with at least one literate member
- ↓ Shorter distances to nearest paved road/city

# Research Question 2

What are the incremental costs of, and expected income generated by, upgrading ‘basic needs’ systems to productive use capacity?

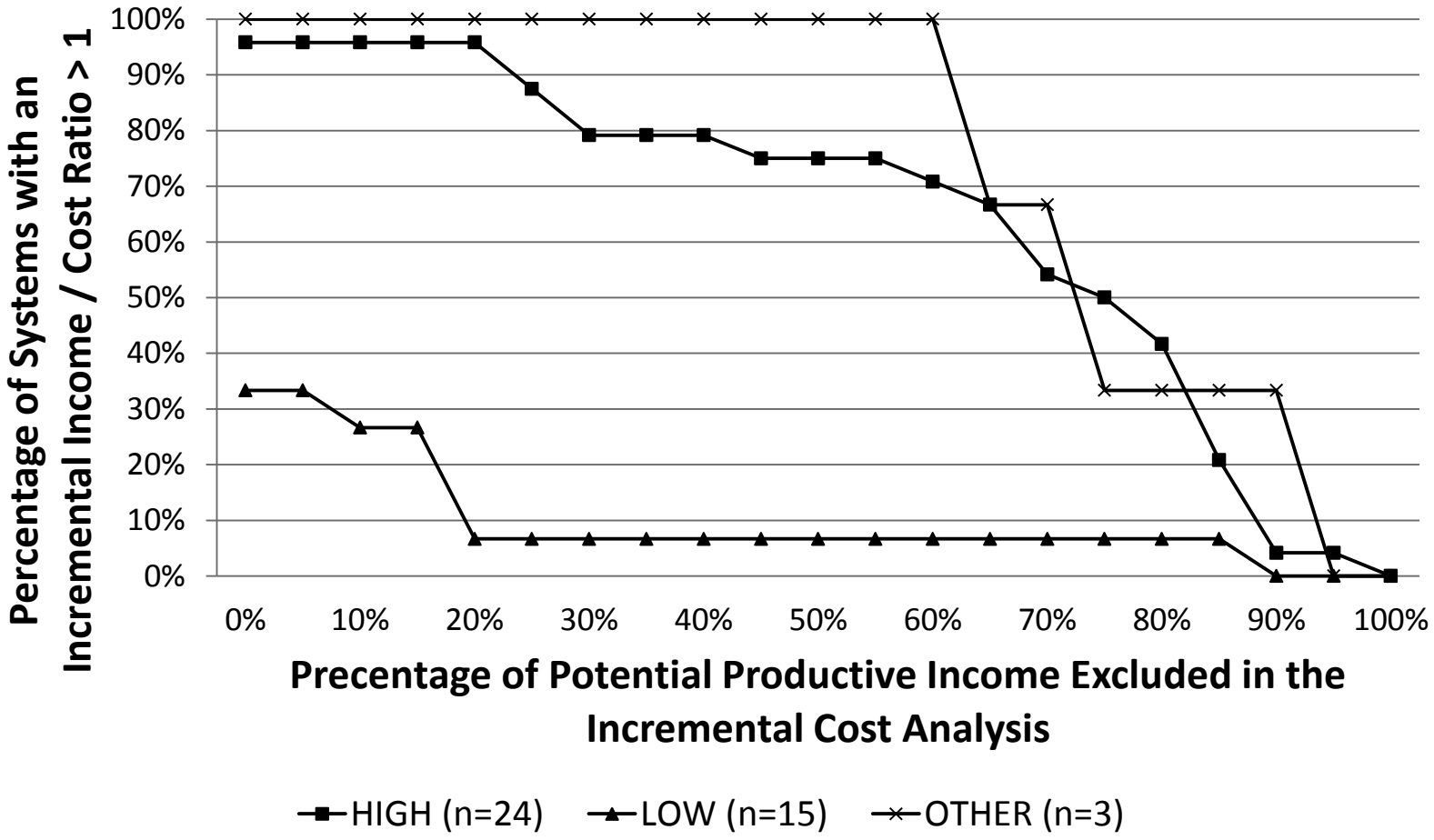
# Approach to Income-Cost (I-C) Analysis

- Calculated the capital and O&M costs associated with the existing piped water systems
- Determined what capital/infrastructure and/or operational changes were required to meet productive-use design flow (*used 47 EPANET models to support analysis*)
- Calculated the incremental costs associated with upgrading each system
- Estimated the additional productive income HHs could generate from the extra productive water

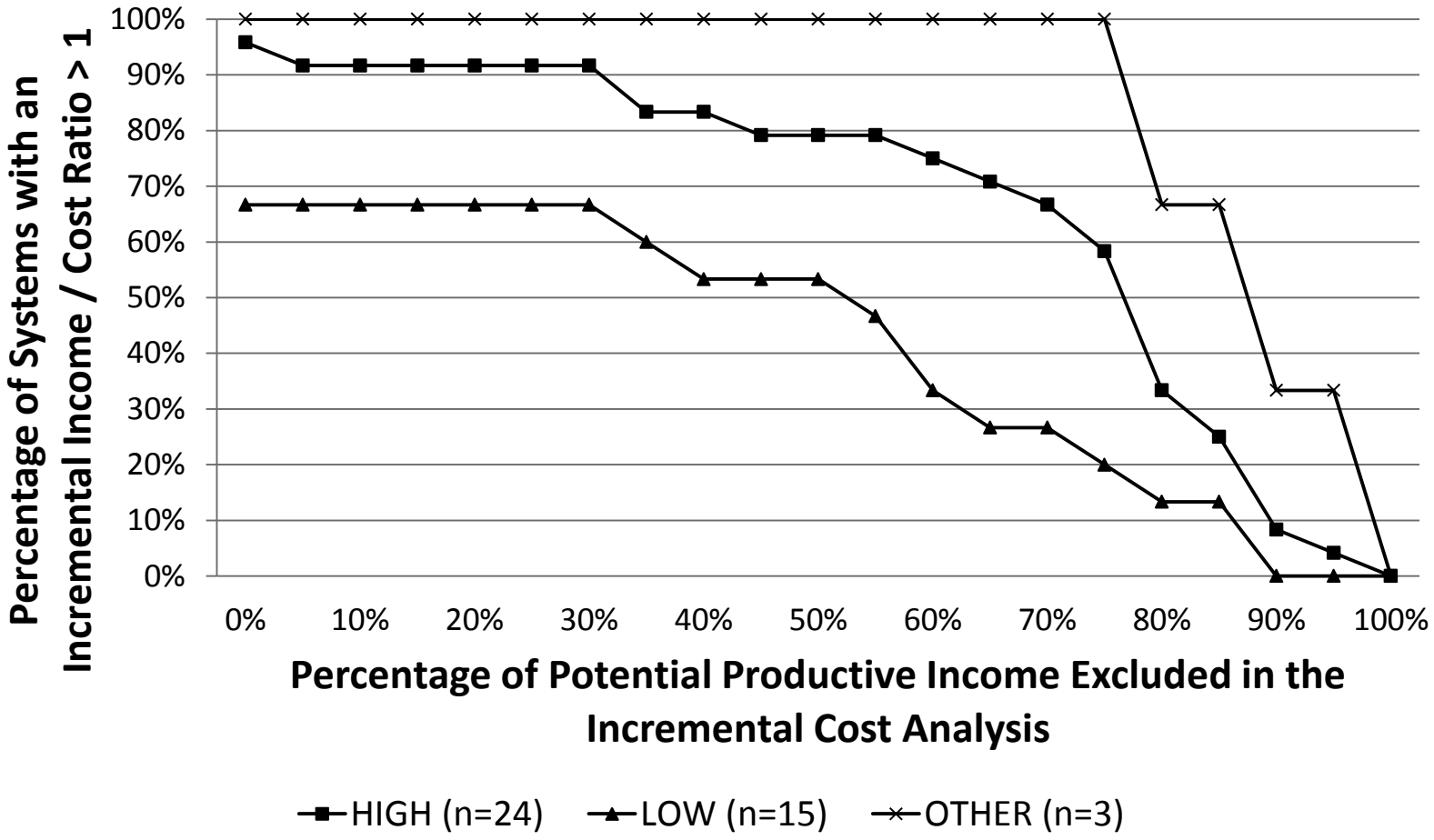
# Can Water Pay for Water?

- For the majority of systems, the theoretical financial benefits to households from additional piped-water-based productive activities are greater than the estimated system upgrade costs
- If all of the potential net annual benefits were directed to repaying the incremental costs of system improvements, the costs would be recovered in approximately one year (*analysis was limited to financial variables only*)

# Sensitivity Analysis of the Income-Cost Ratios – *Productive Income (Piped Water) Variable*



# Sensitivity Analysis of the Income-Cost Ratios – *Productive Income (All Water Sources) Variable*



# Research Question 3

What evidence exists regarding the financial/technical sustainability of piped water systems used for income-generating activities?

# Financial Sustainability Index (FSI)

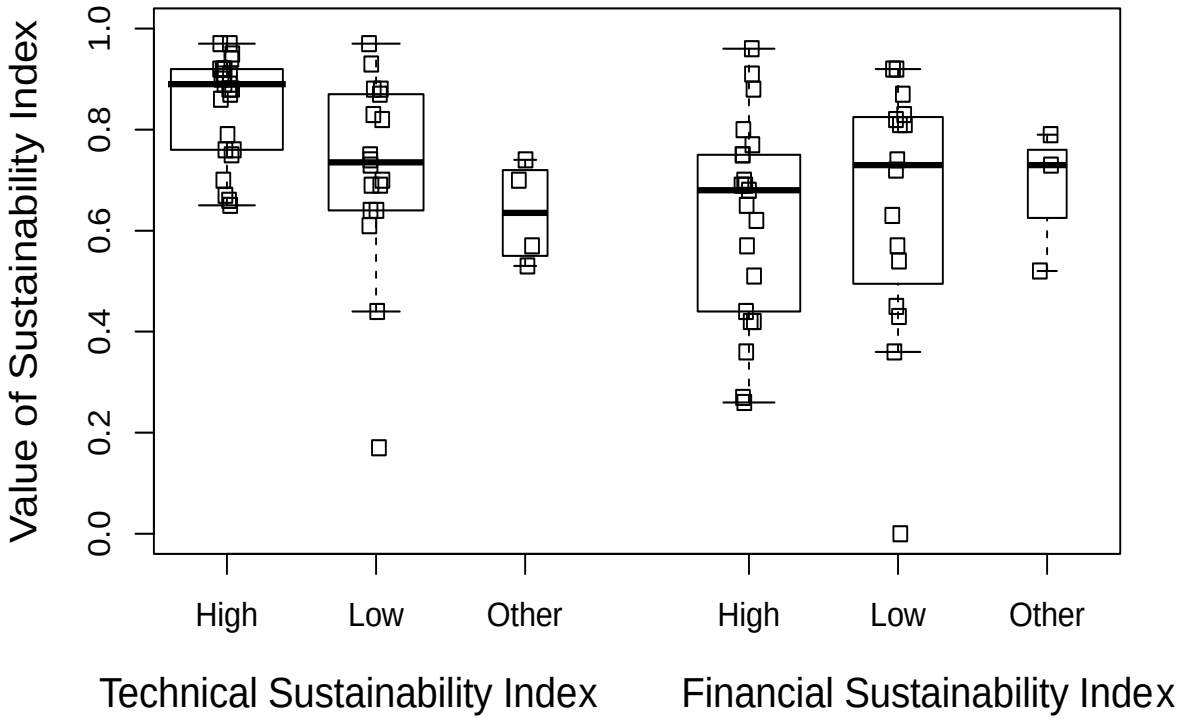
- The FSI was created from the reported working ratio for each system:

**Working Ratio = Annual Recurrent Costs / Annual Revenue**

- Note: We have limited confidence in in the working ratio due to poor quality of raw data

# Technical Sustainability Index (TSI)

- The TSI was developed from three individual indexes:
  - Community Perceptions: A subjective measure of the community's belief that the system will continue to function in the next 1 and 5 years (*asked of the water committee, water operator, leader, and household surveys*)
  - Percent of System Operational: The percentage of major system components that are operational (*developed using data from the water committee interview*)
  - System Breakdowns: A measure of the number of system breakdowns that have occurred in the past year (*as reported by respondents in the household survey*)




- **TSI**: High productive use systems had, on average, greater technical sustainability than Low systems ($p=0.02$)
- **FSI**: High and Low productive use systems had, on average, similar financial sustainability ($p>0.7$)

# Research Question 4

Who benefits when piped water supply systems are used for productive purposes?

# Characterizing Productive Use Households

- The poorest HHs tend to not undertake water-based productive activities
- Poor HHs earn less absolute income from productive activities than wealthier HHs, but are more dependent on this income
- Earning an income from productive activities (regardless of the water source) is associated with higher total household incomes and owning more livestock units
- Use of *non-piped water* is associated with more livestock units and higher incomes

# Benefits for Women

- Women earn 13% of total monthly HH income (*men earn 87%*)
- Women earn 35% of their income from water-based productive activities (*men earn 33%*)
- Women's productive income accounts for 5% of total monthly HH income (*men's accounts for 29%*)
- Wealthier women earn more income (in absolute terms) from productive activities that poorer women
- Improved water access allows women to expand and enter new income generating activities
- Women in wealthy HHs are more reliant on income from productive activities than the men in these HHs

# Results from Women's Focus Groups

- Women's livelihoods are highly dependent on water-based activities – especially livestock raising and gardening
- **Noted benefits**: reduction in workload; health, sanitation, and hygiene improvements; time to rest and participate in community affairs; improved housing; greater school attendance by girls
- **Women spend their income on**: livestock raising, food, health care, commerce, education and clothing

# Many Constraints Prevent Greater Benefits from Piped Water (from Women's Focus Groups)

## Water system constraints:

- Poor water quality
- Frequent breakdowns
- Limited water quantity
- Cost of water and tariff structures

## Non-water based constraints:

- Weak control over income
- Poor access to markets
- Lack of fodder for livestock
- Conflicts between herders and farmers
- Access to land
- Population growth, demand exceeds supply

# Policy Implications

- Upgrading existing rural piped water systems in Senegal to support productive activities is technically and financially viable
- Greatest benefits from water system upgrades can be expected in communities:
  - with easy access to cities and markets
  - with a high percentage of people already participating in productive activities, especially livestock raising
  - that lack access to non-piped sources, especially surface water
- Need to consider how piped and non-pied water can be integrated into a multiple-use service approach
  - Only upgrading piped water systems could ignore important benefits from productive activities supported by non-piped sources

# Policy Implications, cont.

- Water committees and water system operators be provided with long-term (external) support and training to enhance their capacity to manage water systems
- Research needed to understand constraints keeping the poorest households from participating in productive activities
- Possible option: **Integrated programming model** that combines water upgrades with other investments such as improving access to markets, credit, and price information, as well as training in literacy and small enterprise development

# Questions?