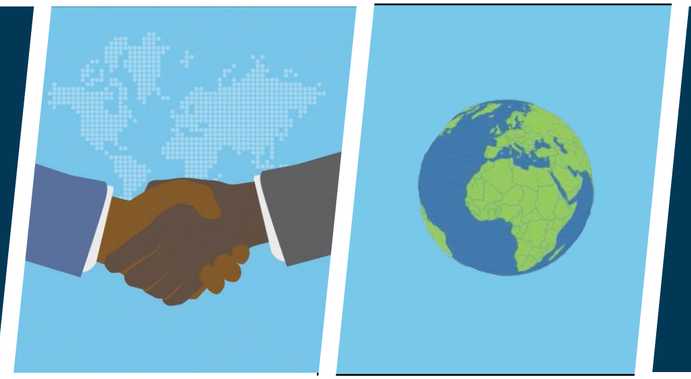
8 Nov
2023

IGM CONFERENCE 2023

TRANSFORMING THE RETURNS TO IRRIGATION INVESTMENTS IN MOZAMBIQUE



EVIDENCE FROM IMPACT EVALUATION EXPERIMENTS

STEVEN GLOVER

DEVELOPMENT IMPACT (DIME), WORLD BANK

THE WORLD BANK
IBRD • IDA | WORLD BANK GROUP
Development Economics • Impact

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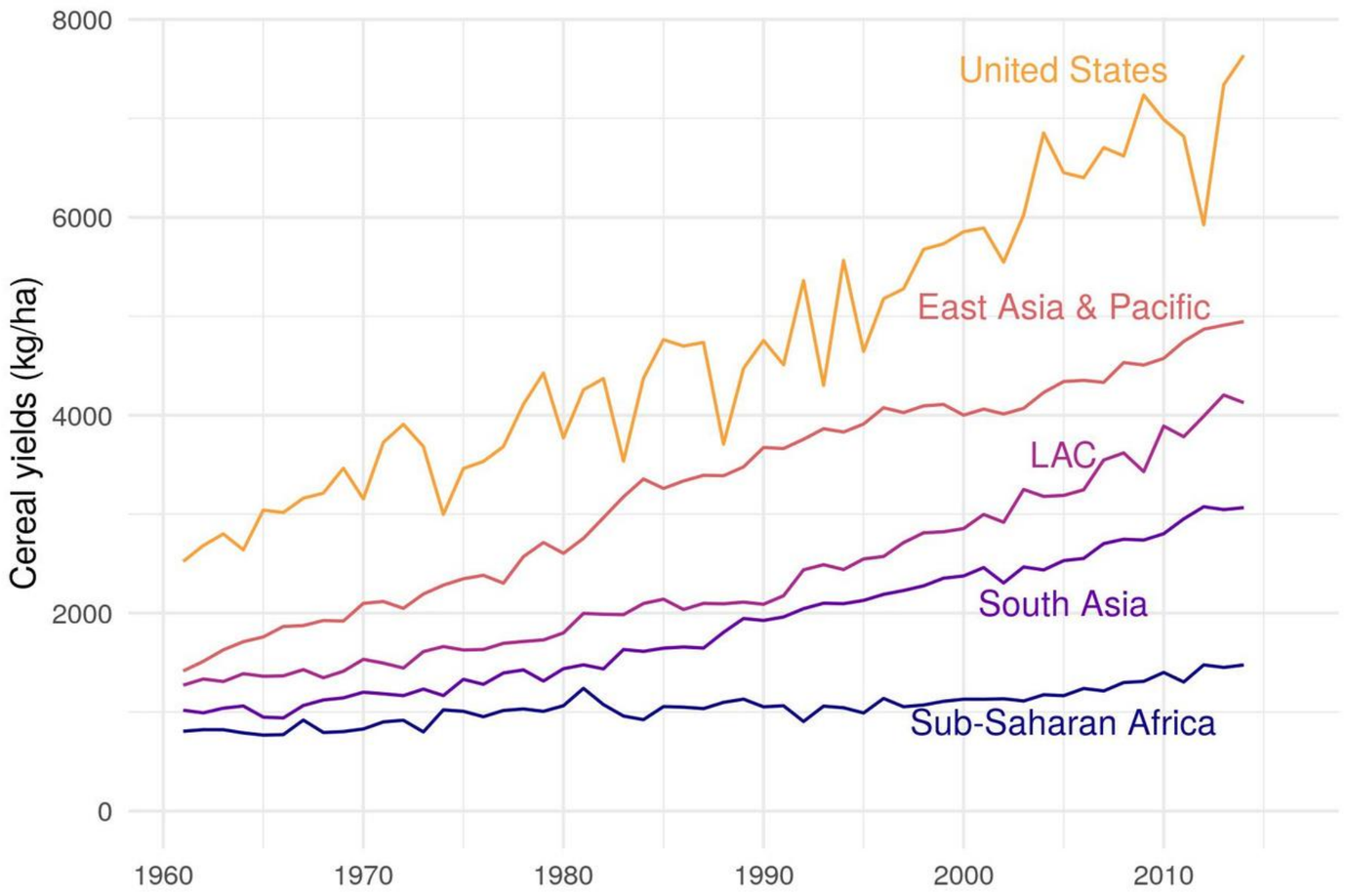
The big picture…

Returns to irrigation infrastructure are not fixed.

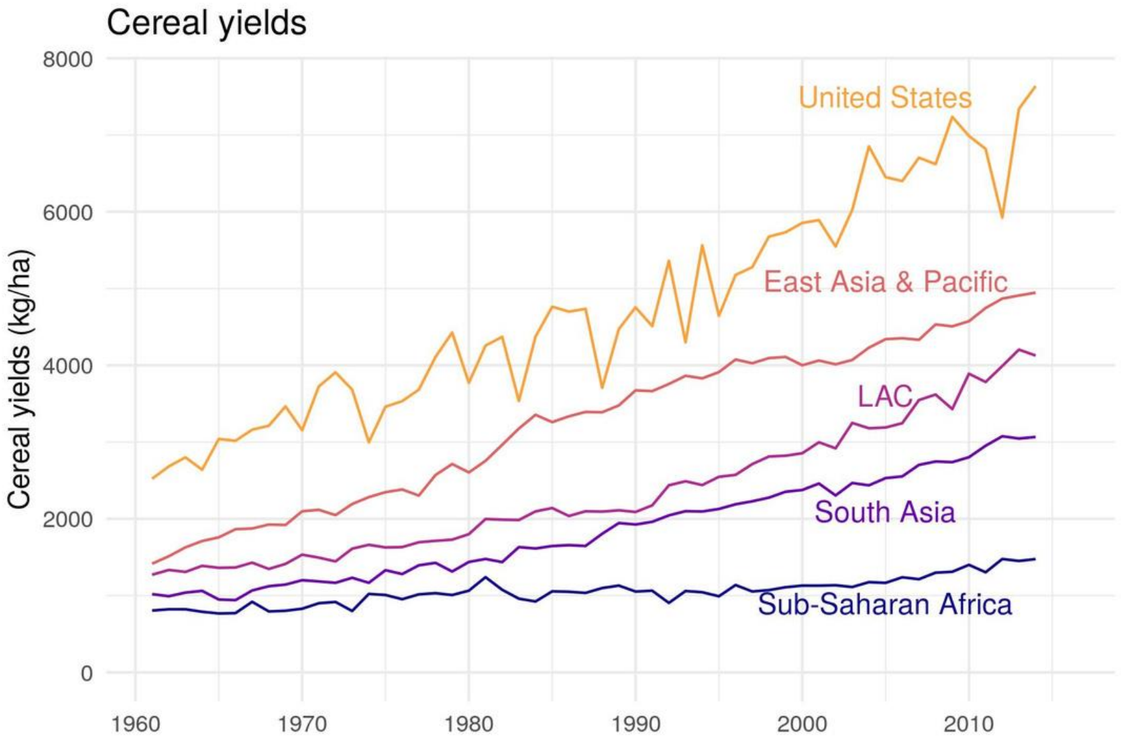
Focusing on adoption and usage can transform these returns.

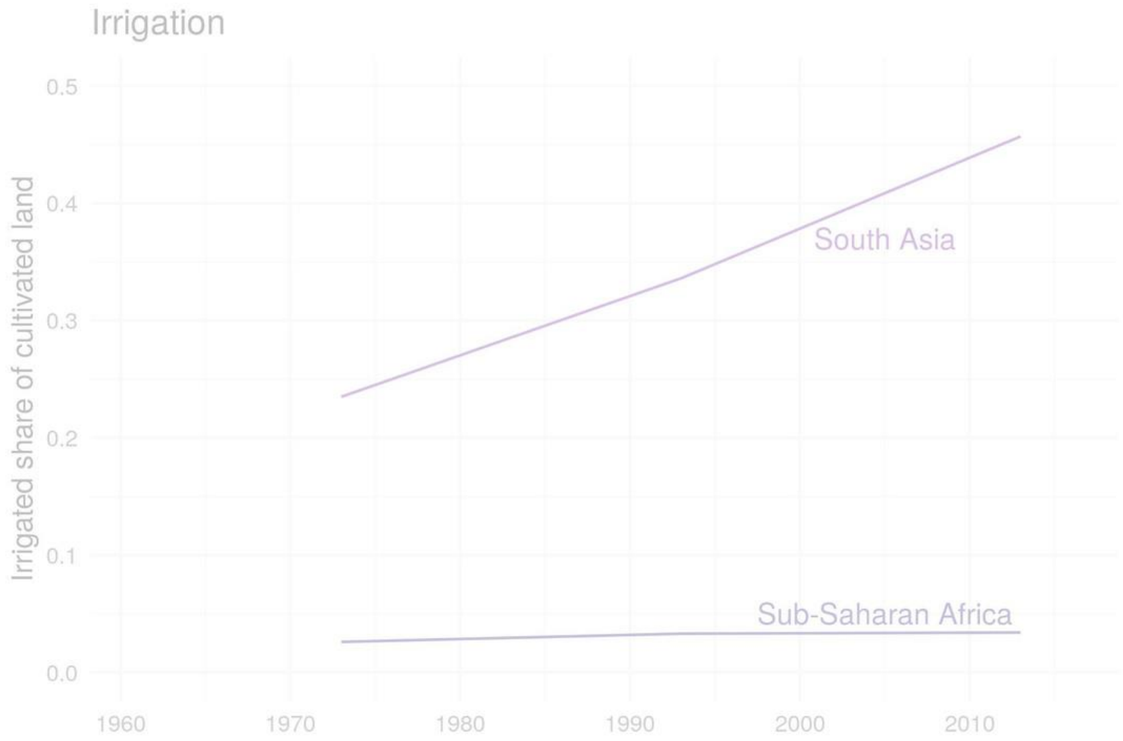
Motivation

Cereal yields growth is low and slow in many parts of the world



Expansion of irrigation access may be an important part of yield divergence





- 3.4% of cultivated land is irrigated in SSA vs 45.7% in South Asia
- Irrigation increases yields by 70% in India (Duflo & Pande, 2007); does the irrigation gap explain the yield gap?

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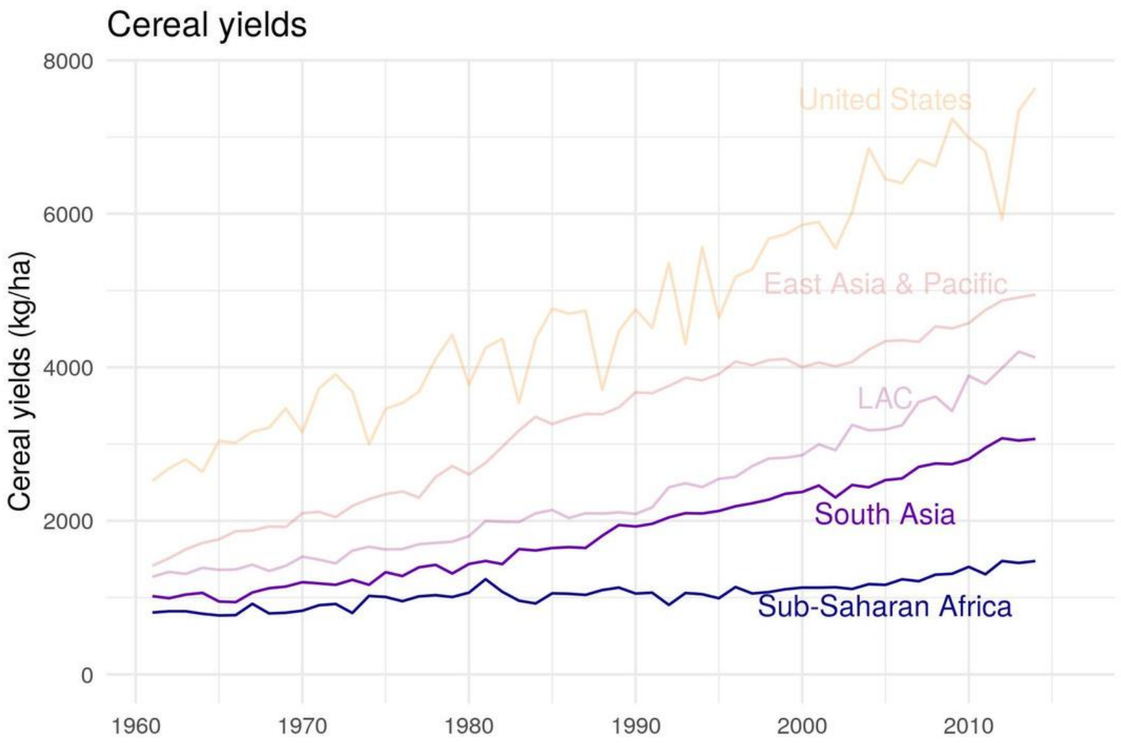

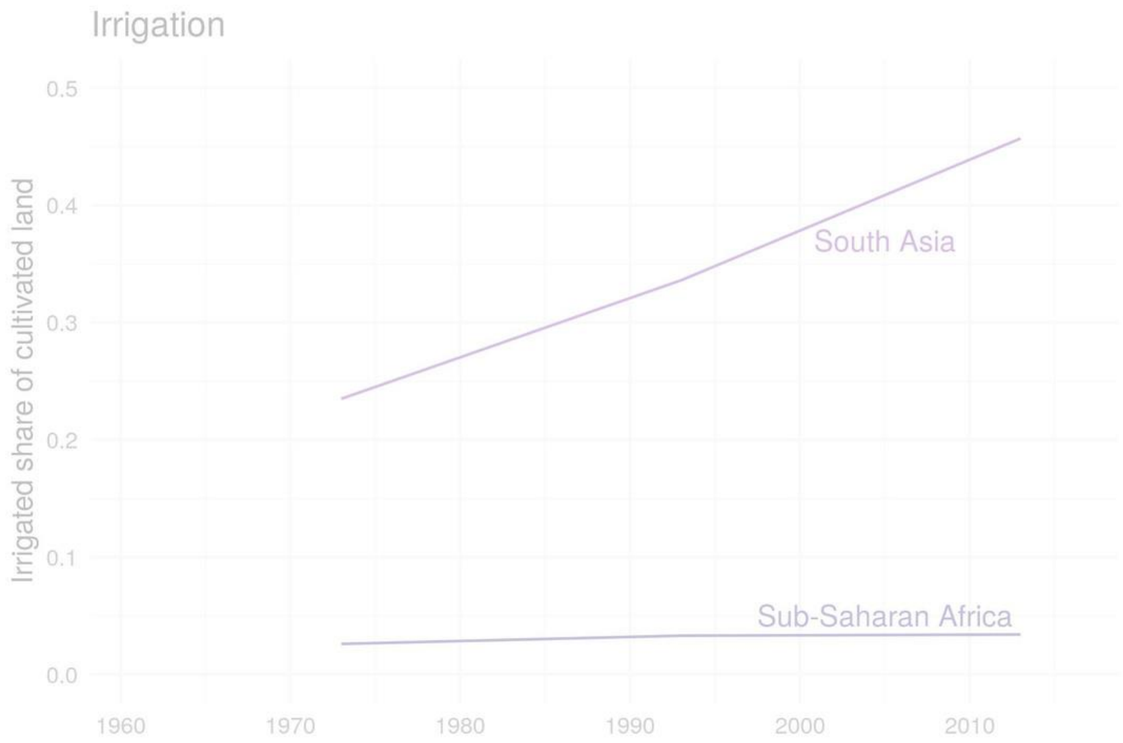

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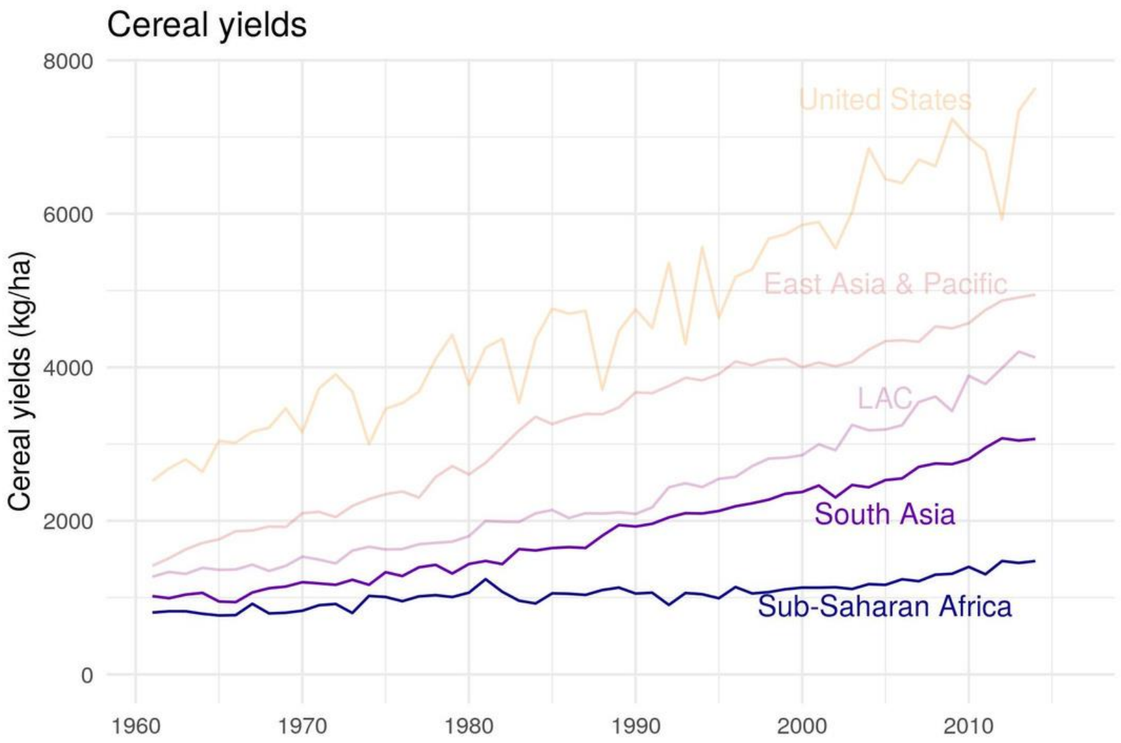

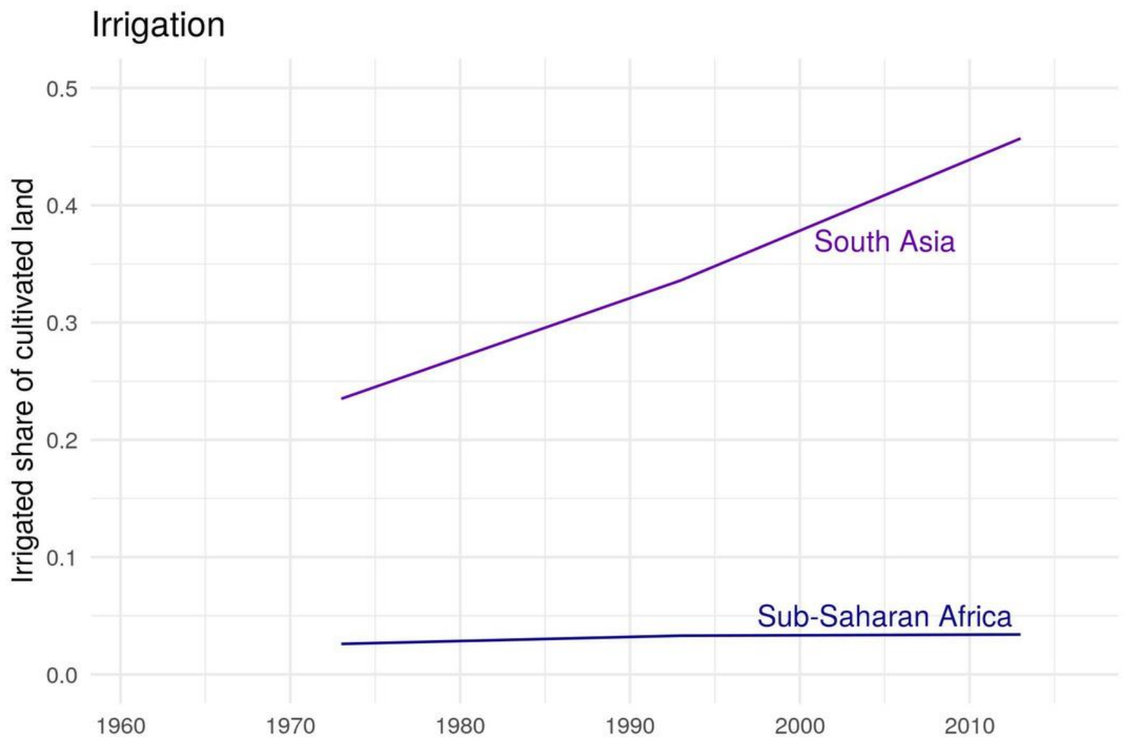

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Irrigation Context

- In Mozambique, less than 10% of irrigable land is irrigated
- 60-80% of annual precipitation falls during the region's single rainy season -- farming is not viable during most of the year
- Increase production through dry season cultivation, reduce risks for switch to cash crops
- Increases farmer resilience to climate shocks
- But we lack systematic evidence on how to deliver irrigation in a sustainable manner

How can irrigation use be optimized?

Field Experiments for Sustainable Irrigation

1. Irrigation is a very productive technology

- Large increase in cash profits for farmers adopting irrigation...
- ...but some farmers don't adopt

⇒ **Why don't farmers use this super technology?**

2. Farmer selection is important

- Smallholder farmers use and maintain irrigation as well as experienced larger farmers

⇒ **Respond to food security concerns of projects**

3. Better monitoring can save money

- Information on water needs and use improve water availability

⇒ **Cheap interventions can vastly increase irrigation scheme efficiency!**

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Irrigation User Targeting in Gaza Province

Sustainable Land and Water Resources Management Project (SLWRMP)

African Development Bank (AfDB)

Selection of beneficiaries: why is it important?

- Ex-ante not clear who should get it:
  - Don't know who will benefit most from irrigation (maximize profit, food security, etc.)
  - Different group structures might better maintain equipment

- The trade-off:
  - Local community may have more information about who would benefit most
  - But if we totally don't place constraints on the choice, there is a risk that the most powerful person in the community will take the kit

Research agenda focuses on targeting and sustainability

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- 54 communities
- 5 or 10 ha irrigation sprinkler system

Who gets irrigation?

Physical Constraints:

- Has to be close to the river
- Coverage is either 5-10 ha
- Avoid forest cover
- Land should not already be equipped for irrigation

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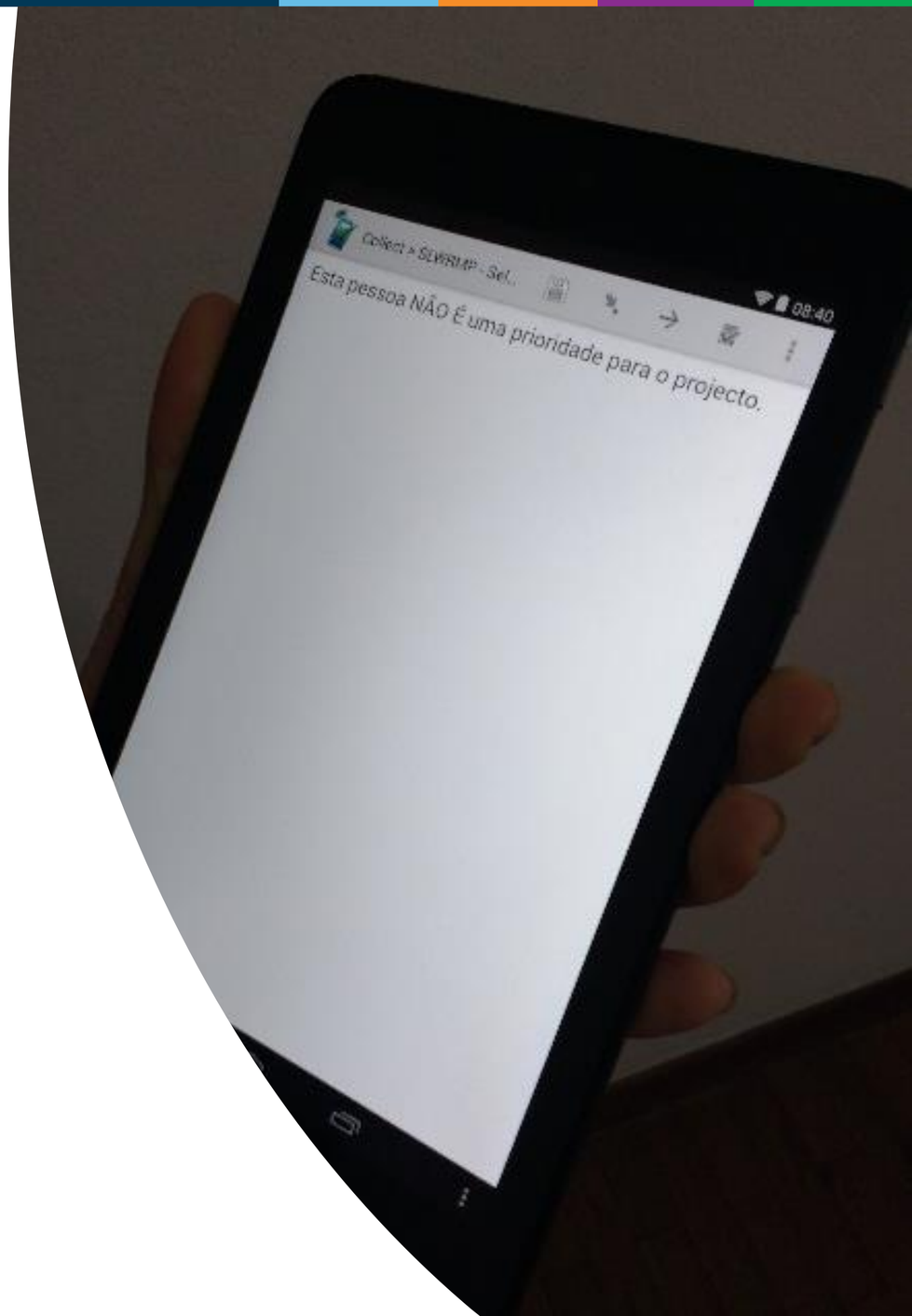
Smallholder Inclusion

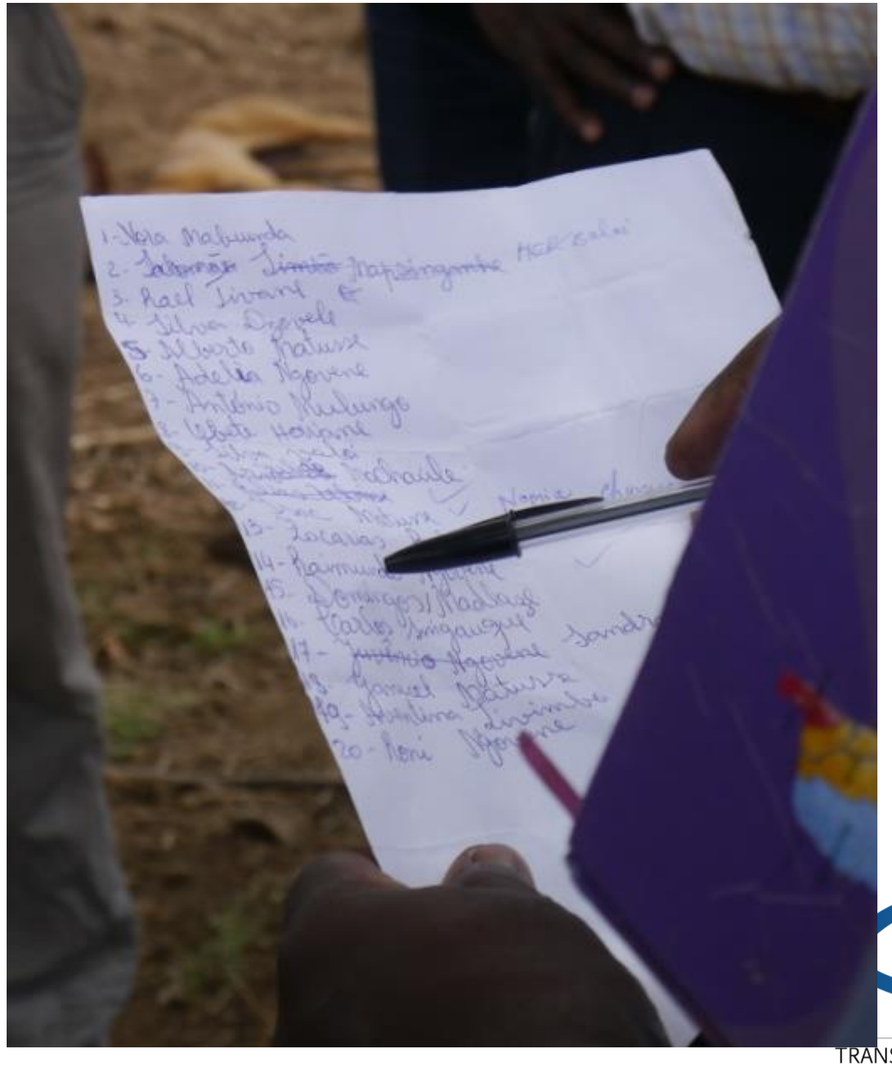
- Every farmer is asked 12 questions about their livelihoods
- Test is designed to predict who falls within the SLWRMP's pre-set target of 0.5-2 ha of landholdings (PMT)

- Meeting is organized with all farmers in the eligible area and PMT is administered to identify all priority farmers
- Project staff identifies area to install the irrigation kit that covers the most priority people



Smallholder priority selection

Decentralized community selection



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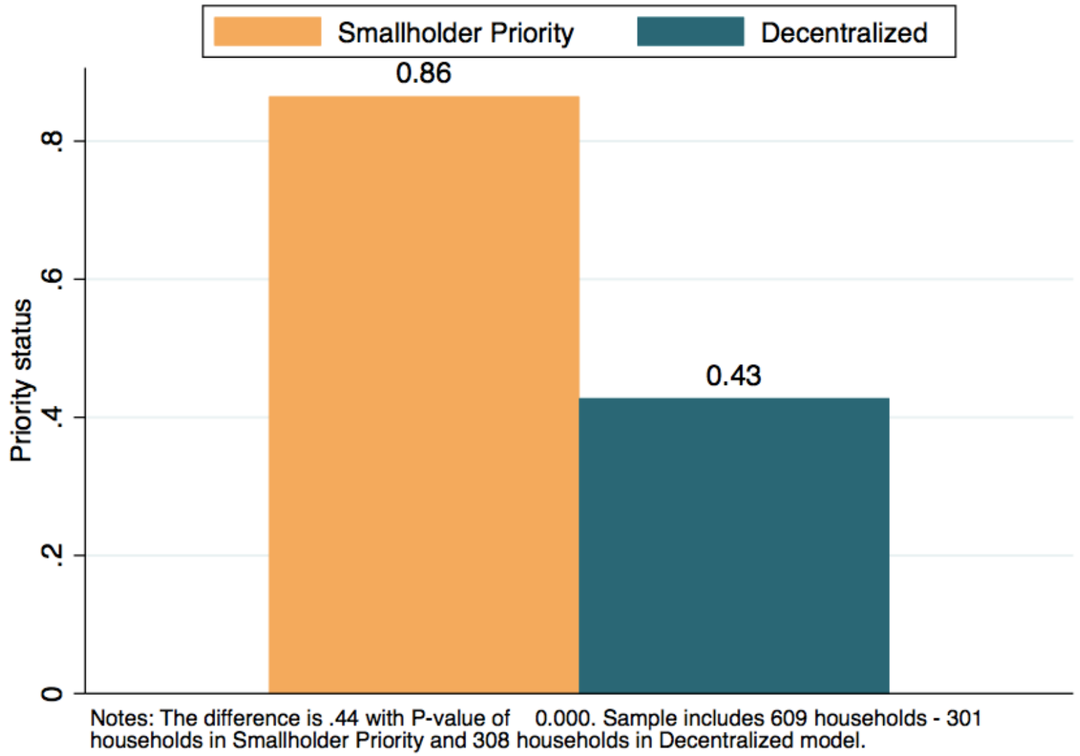
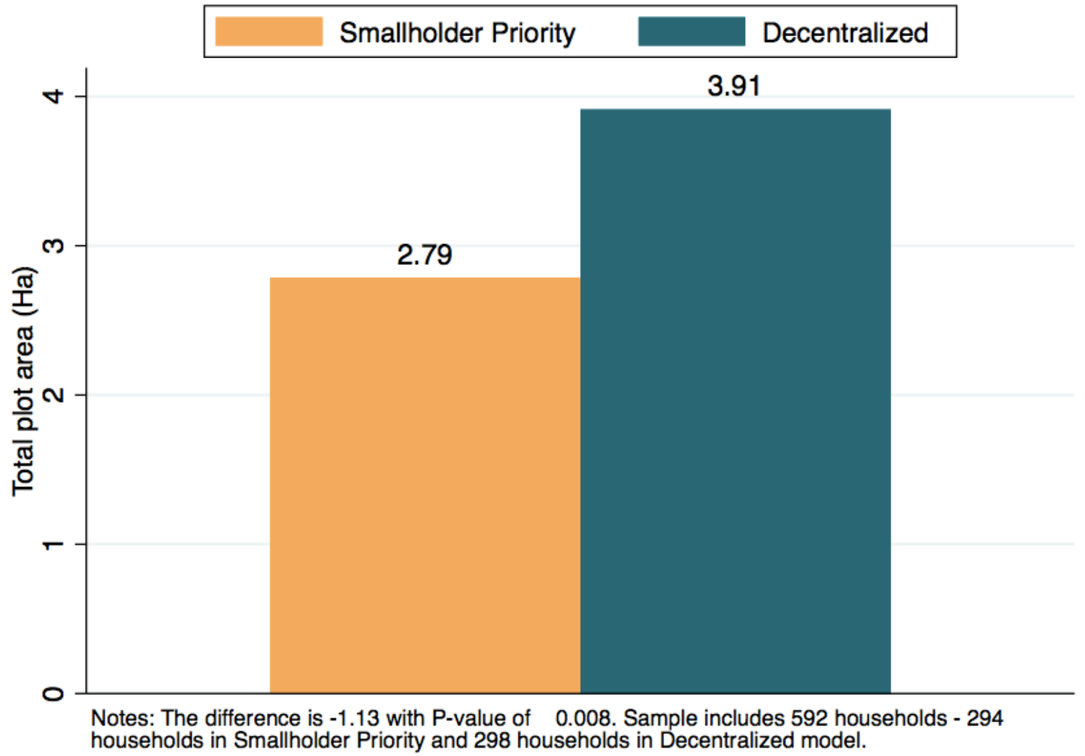
First, does the smallholder priority protocol select more priority people? Yes.



Higher PMT score



Smaller average land size

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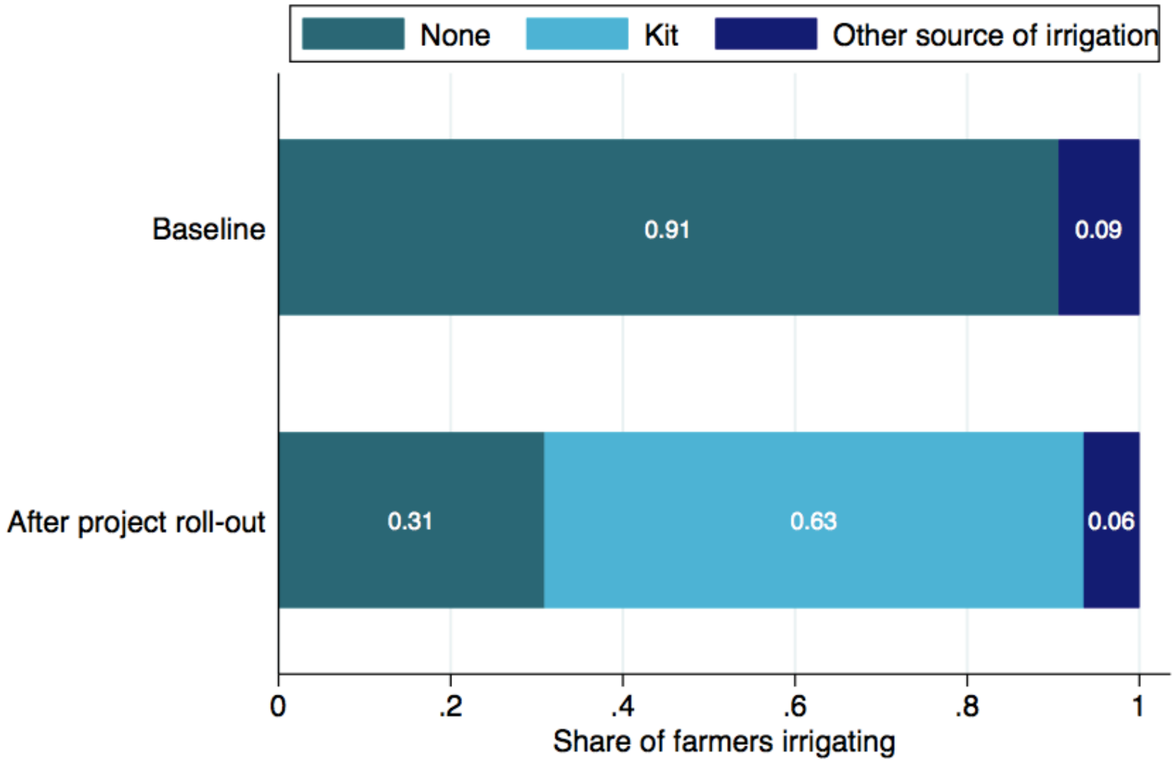
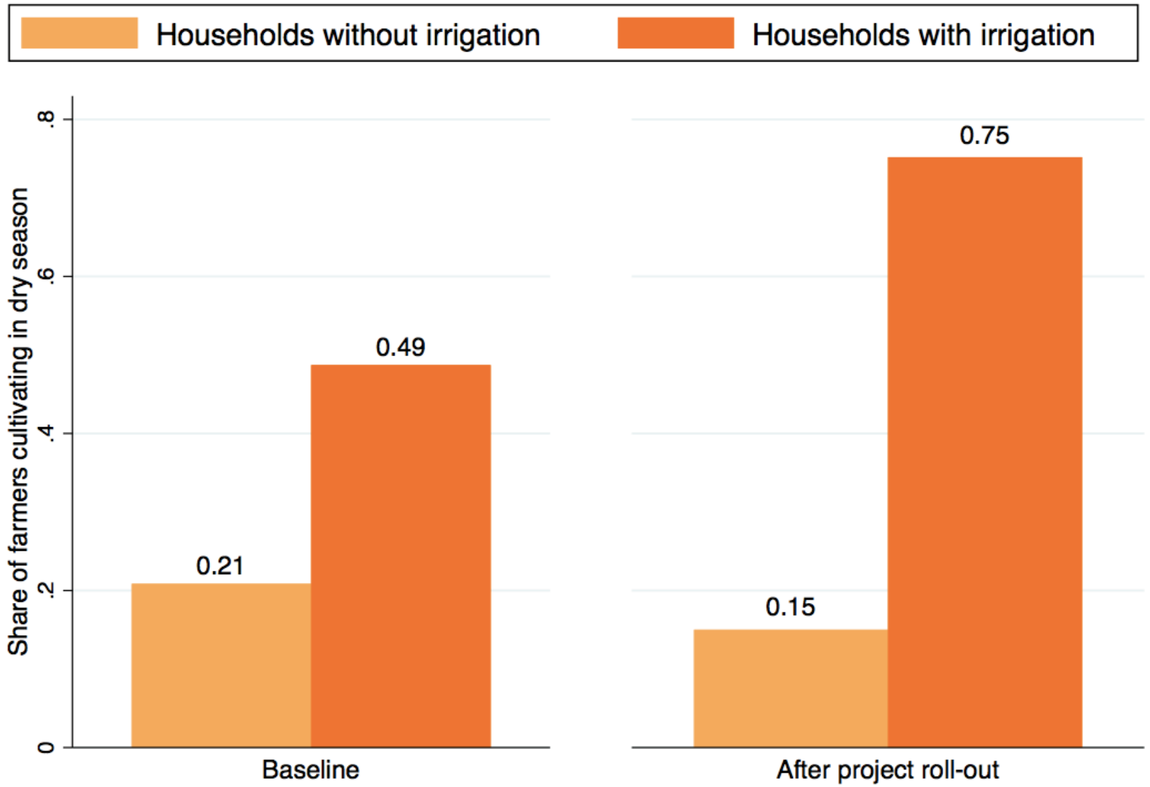
Smallholder priority selection

Decentralized community selection

As expected, many more farmers are using irrigation



Sample is restricted to households assigned to kit at baseline or using kit at midline or endline. (N = 1120)



Sample is restricted to households assigned to kit at baseline or using kitat midline or endline (N = 1,115).

Dry season cultivation increases, even among households that had irrigation before.

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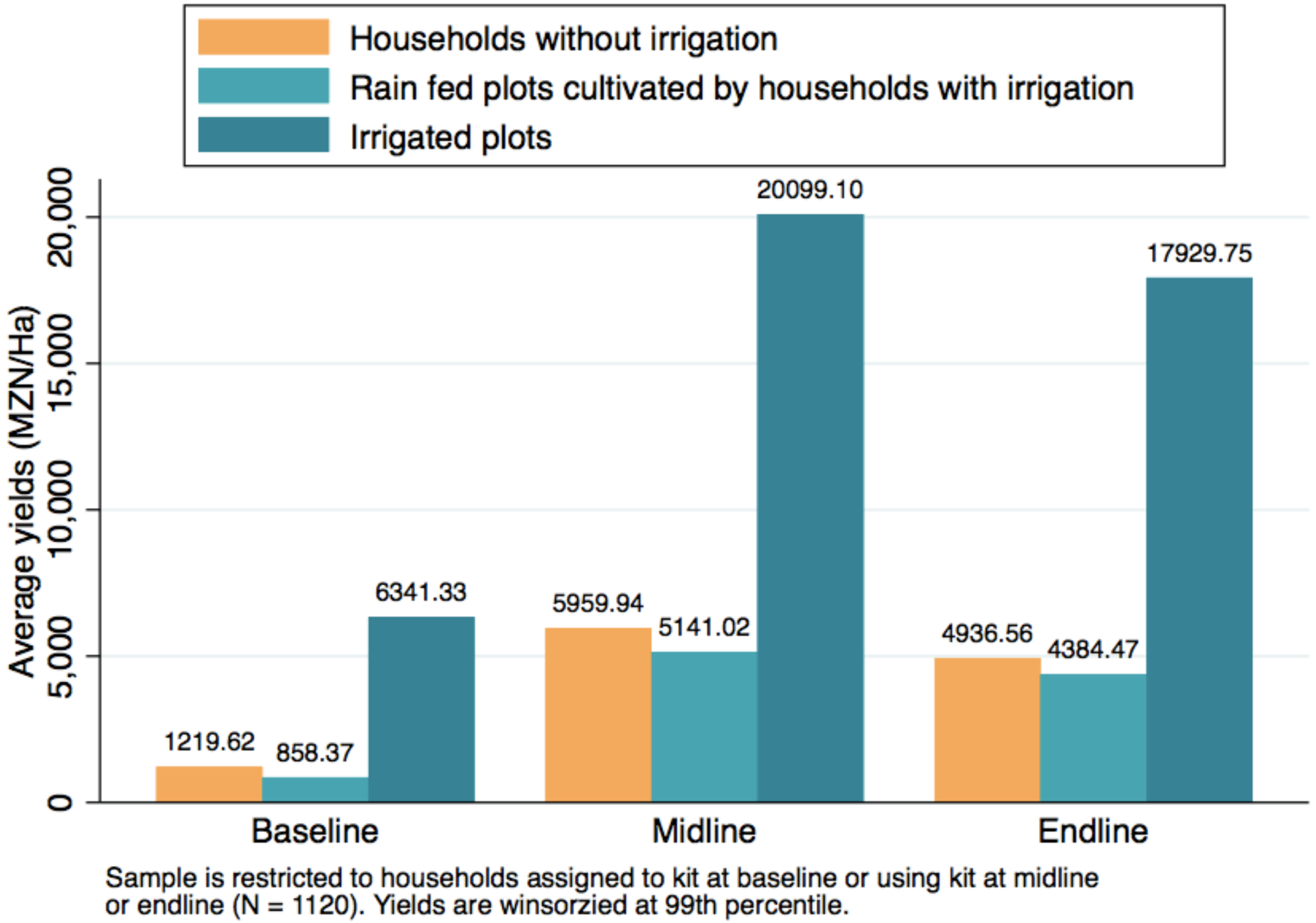
Crop production was MUCH higher on irrigated plots



Sample is restricted to households assigned to kit at baseline or using kit at midline or endline (N = 1120). Yields are winsorzied at 99th percentile.

Revenue per hectare was 3-4 times larger over an entire agricultural season

(not causal)

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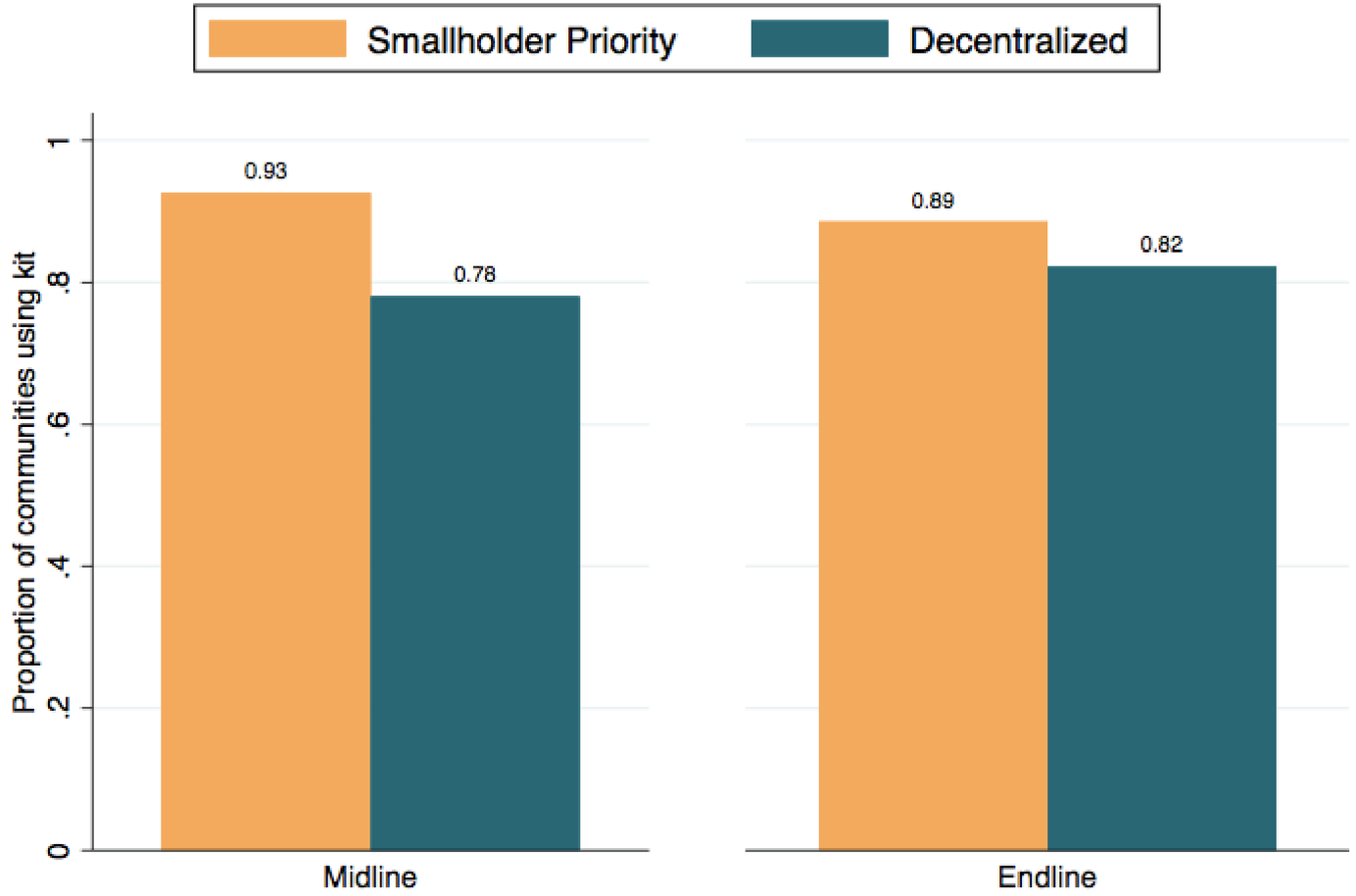
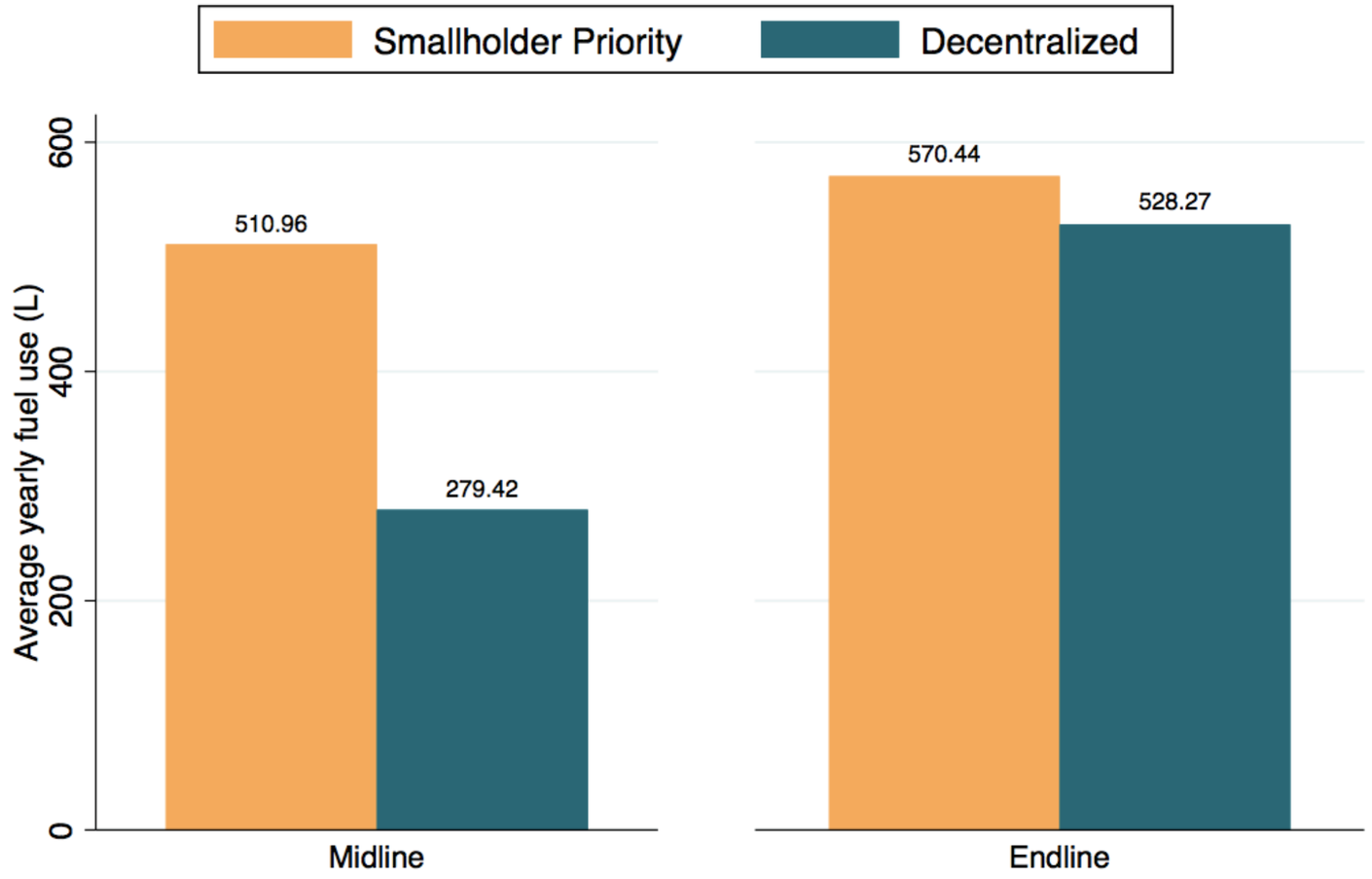
How did group composition affect the usage of the irrigation kit?

Differences are small, but communities that prioritized smallholders … were not less likely to have an irrigation kit that worked



P-value of difference under robust standard errors for ML and EL is 0.107 and 0.529 respectively.
Prediction is net of strata fixed effects. Sample includes 55 communities.

Differences are small, but communities that prioritized smallholders … used more fuel



P-value of difference under robust standard errors for ML and EL is 0.130 and 0.810 respectively.
Prediction is net of strata fixed effect.
Sample includes 45 and 53 communities that reported positive fuel contributions in ML and EL respectively.

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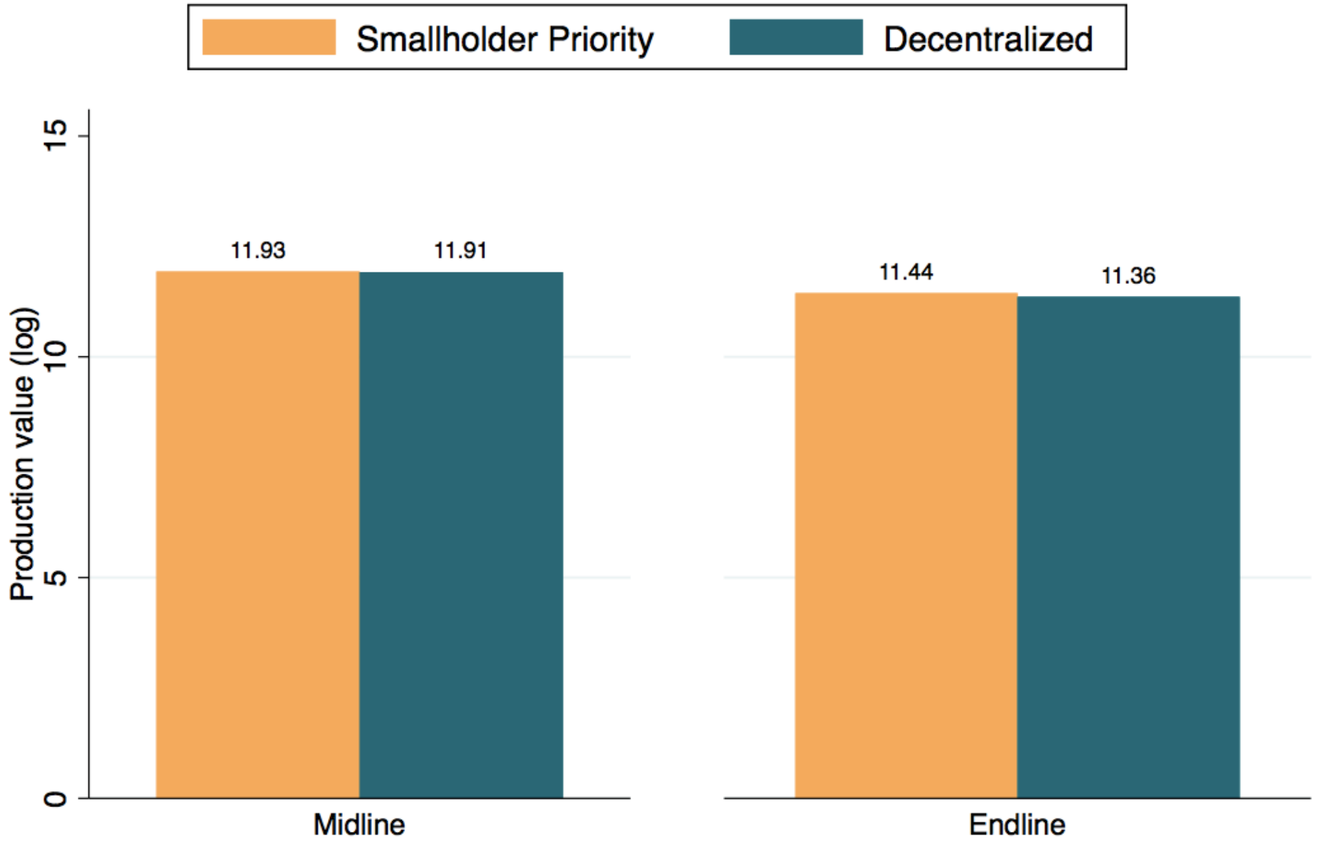
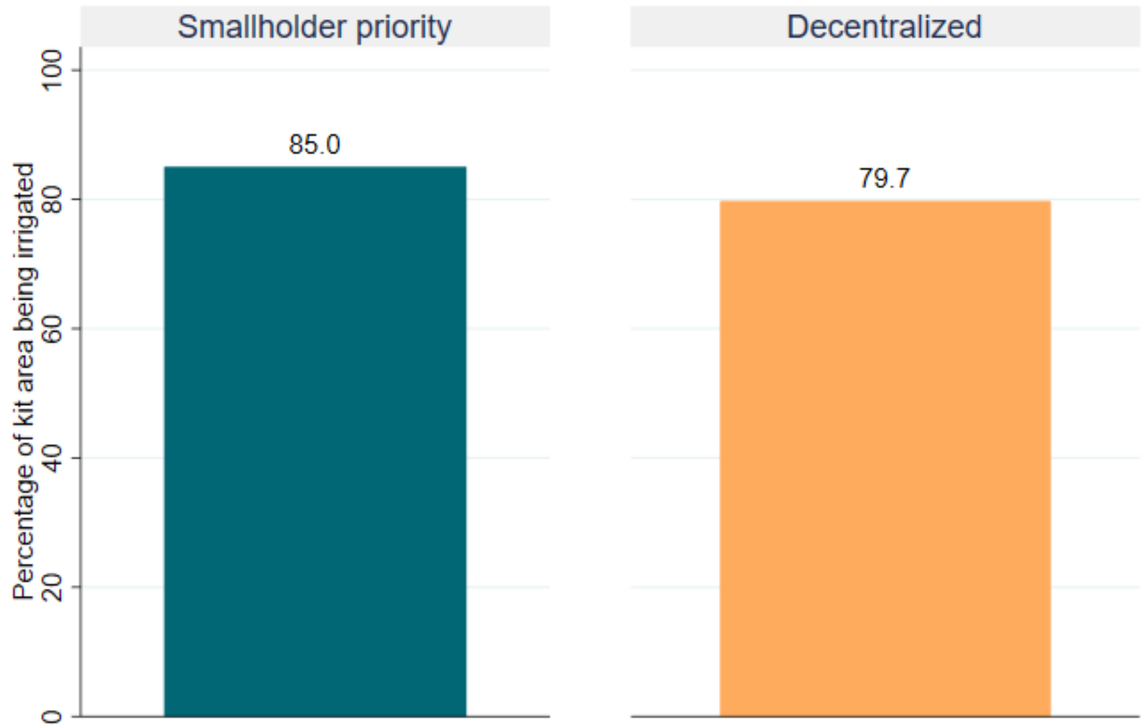
Differences are small, but communities that prioritized smallholders … had the same levels of production (no less efficient)



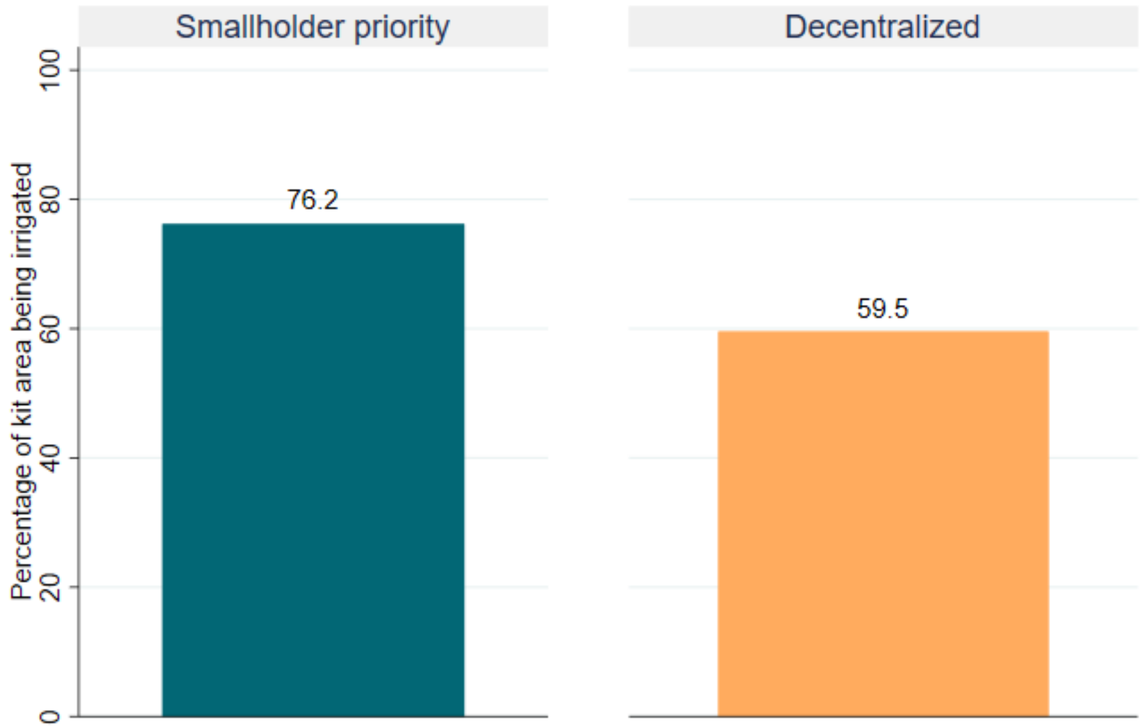
P-value of difference under robust standard errors for ML and EL is 0.945 and 0.714 respectively.
Prediction is net of strata fixed effects. Sample includes 48 and 51 communities that had plots inside kit-area.
Producation value (log) is winsorized at 99th percentile

Area of the irrigation kit being used decreased faster in the decentralized communities



P-value of difference under robust standard errors is 0.704. Prediction controls for kit size fixed effect.
Community level irrigated area is obtained by adding the area irrigated in kit plots on household survey.
Sample includes 49 communities.

MIDLINE



P-value of difference under robust standard errors is 0.355. Prediction controls for kit size fixed effect.
Community level irrigated area is obtained by adding the area irrigated in kit plots on household survey.
Sample includes 45 communities.

ENDLINE

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To summarize

- Leaving beneficiary selection to the community results in larger farmers being selected to participate
- Prioritizing smallholders does not seem to lead to worse performance of the irrigation kits
- If anything, they perform slightly better in keeping the kit functioning over time

** Paper coming later this year*

Irrigation Water Monitoring in Manica Province

Sustainable Irrigation Development Project (PROIRRI)

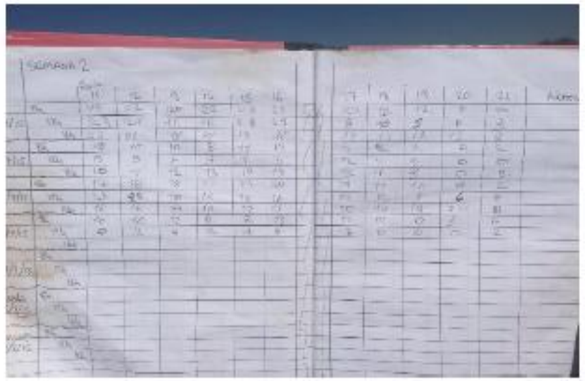
World Bank

PROIRRI Water Measurement Intervention

(Christian, Kondylis, Mueller, Zwager, Siegfried, 2021)

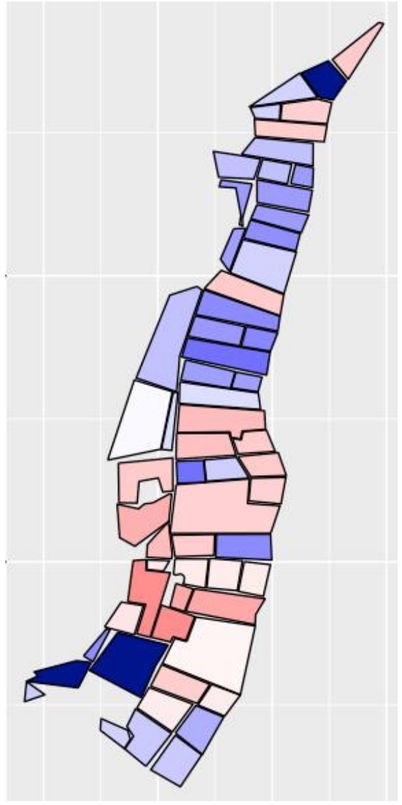
- Engineers train WUA members to collect flow and depth measures at calibrated points to estimate volumes

- Community data collectors record water depth **3 times per day**
- Extension service agents collect field data and report to central level

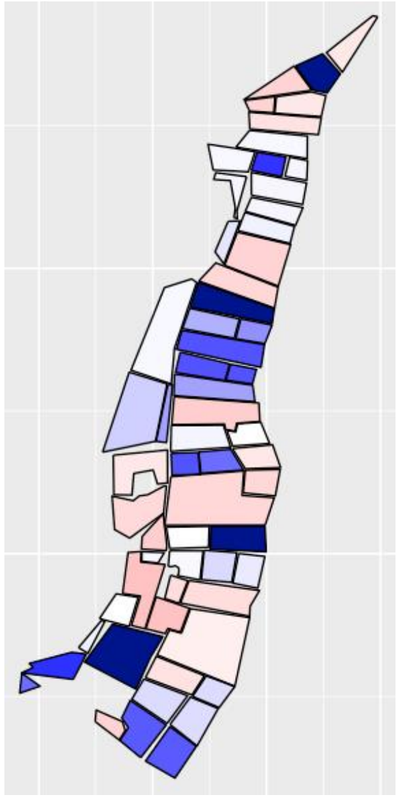


We observe water shortages in large areas of the irrigation scheme

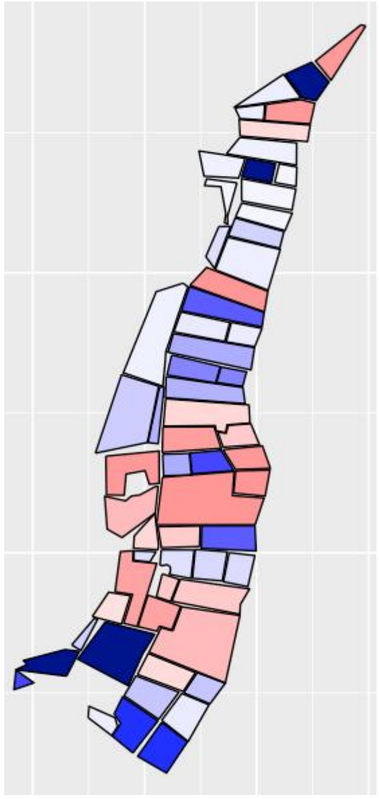
July



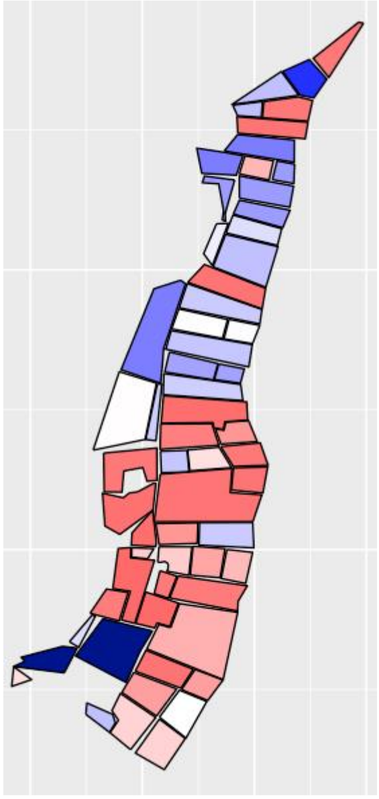
August



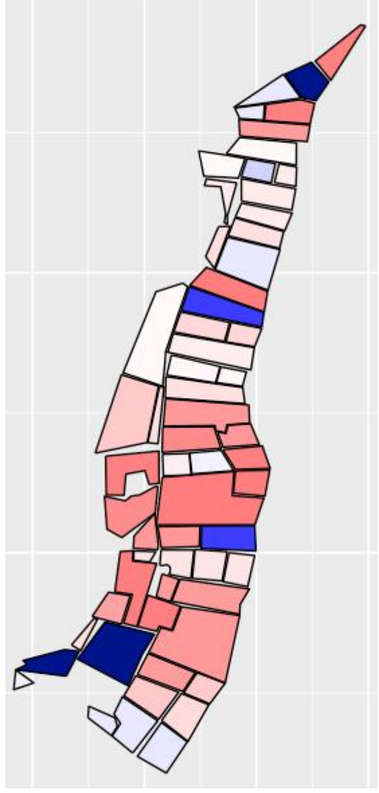
September

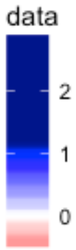


October



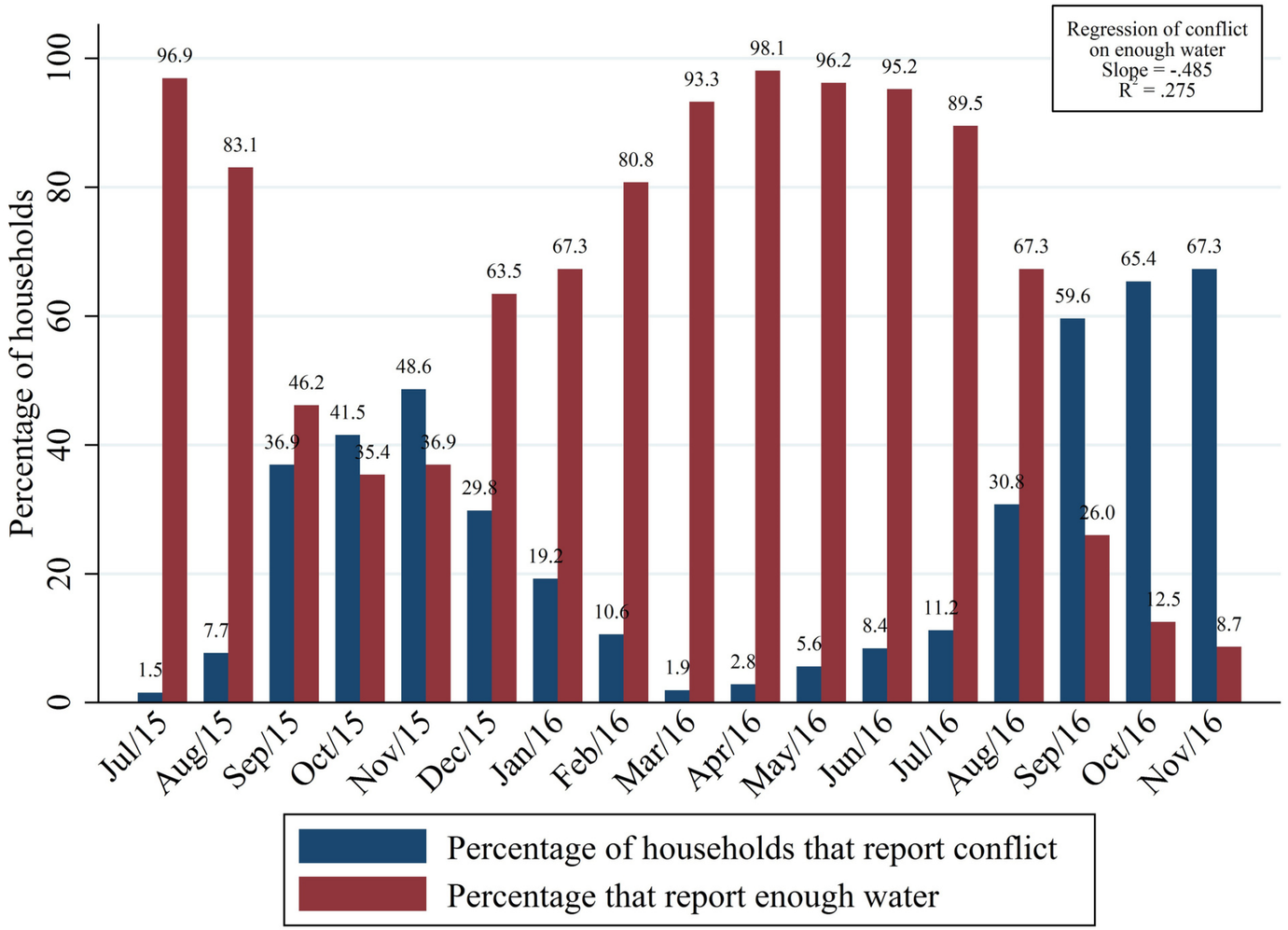
November





The zscore values were centered by the median water availability over all fields in the scheme, i.e. 61. Blue hues indicated positive zscores where red hues indicate negative ones correspondingly. Two fields (13701 and 13201) show extreme positive deviations of the corresponding zscore values. The underlying reason of these extreme values needs to be further investigated.

Conflict over water is rampant when water is scarce



But is this because:

- There is not enough water?
- Some overuse the water?

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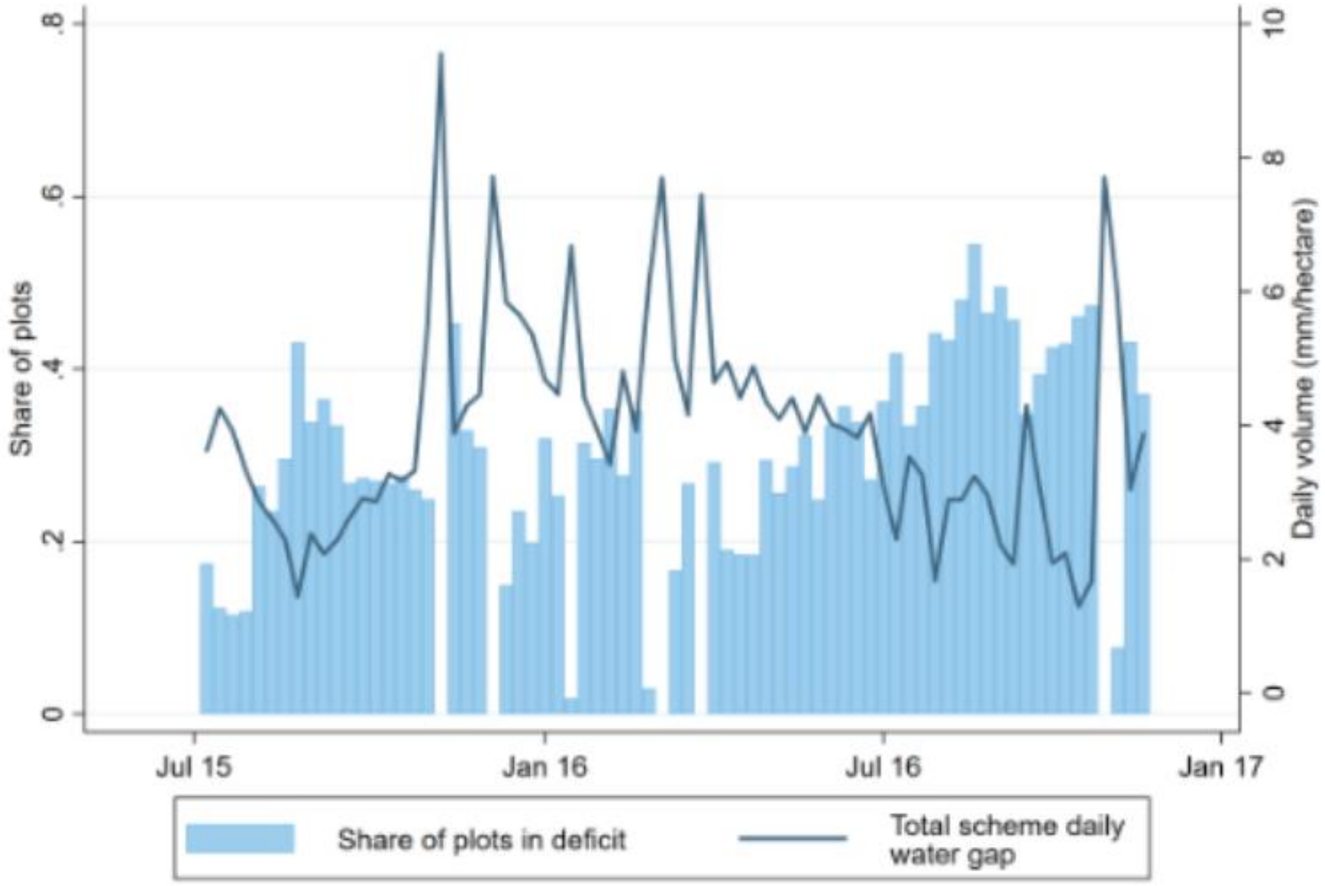
Observation #1: There is always enough water in the system!



The engineers did a good job!

Yet, half of the plots don't get enough water …

- How do we *cost-efficiently* regulate use?

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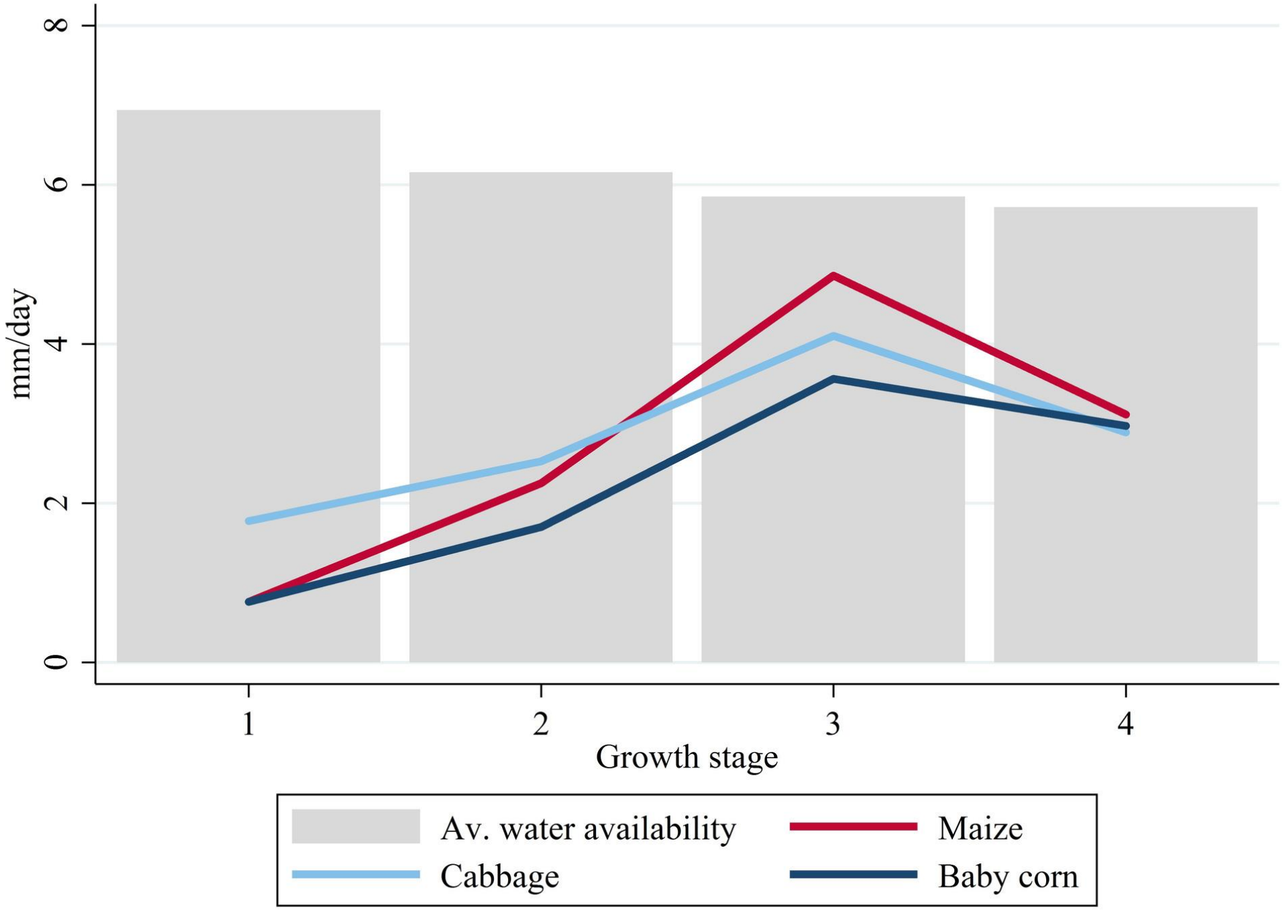
Observation #2: Farmers misallocate water across the crop cycle



- Farmers didn't follow crop water requirements
- This inflexibility wastes enough water to create scarcity over all plots

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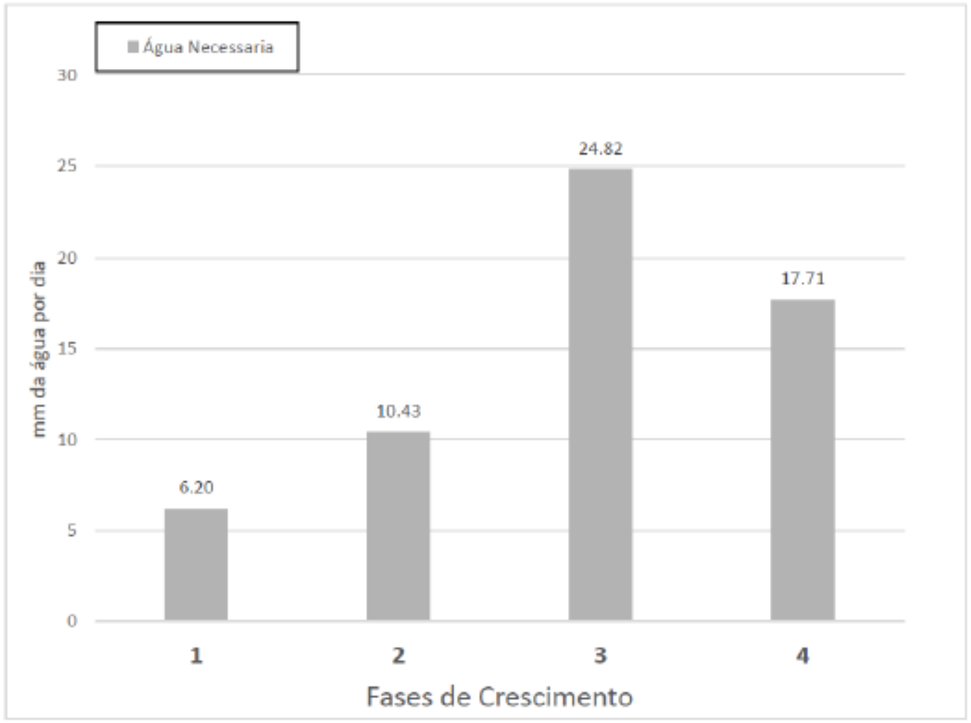
Feedback experiment: Basic requirement vs Precise measurement

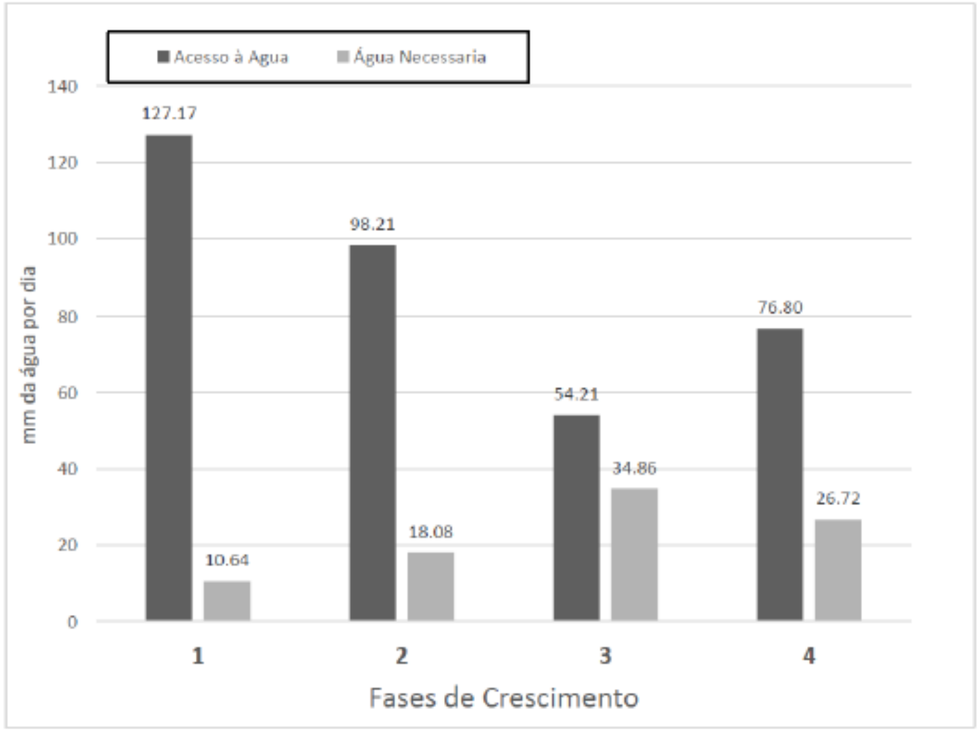
Nome da Cultura: Piri-piri



Dias em cada fase:	28	22	20	5

General Feedback: Specific only to crop

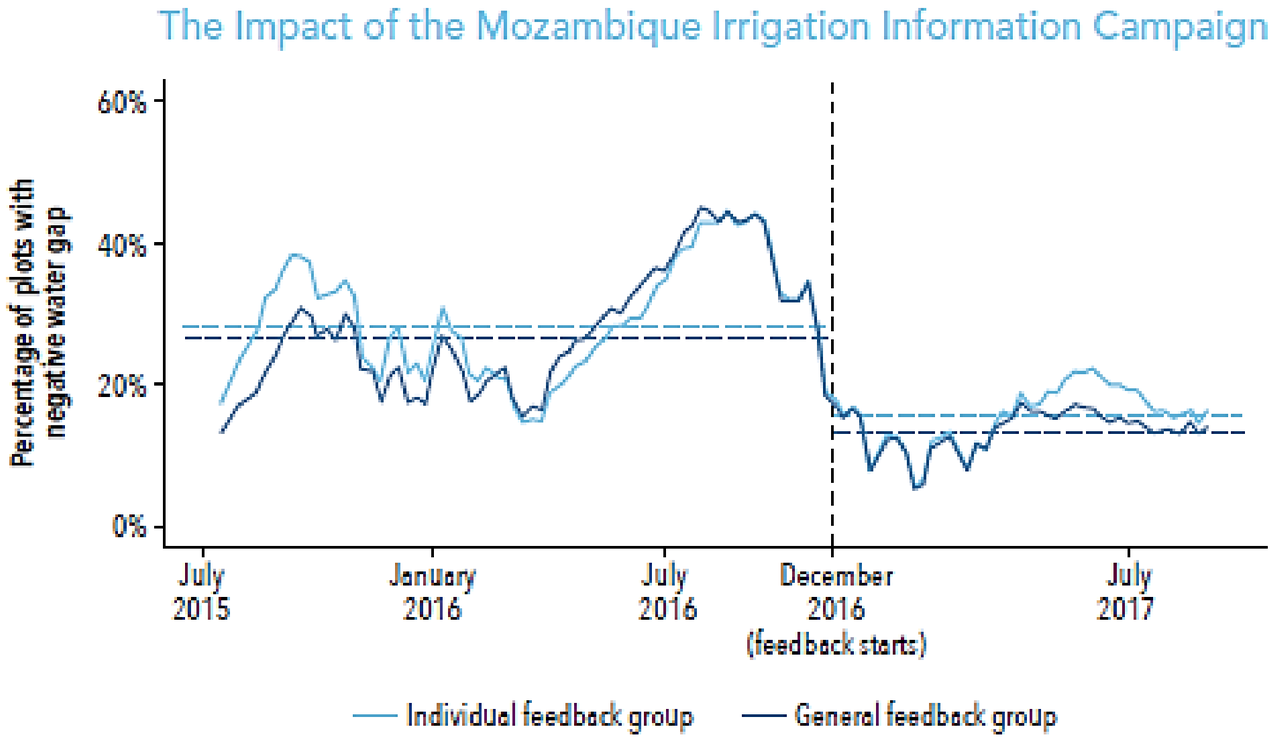
Nome da Cultura: Tomate



Dias em cada fase:	30	40	45	30

Individual Feedback: Every farmer's use measured

Sharing basic watering requirements worked just as well as expensive monitoring!



Note: The figure shows the eight-week moving averages of plot-crop-week observations. The solid lines show the proportion of plots (on the y-axis) in a given week (on the x-axis) where the water available in canals adjacent to monitored plots is less than the amount required. This is also known as a "negative water gap." The two sets of horizontal dashed lines show the averages of plots associated with each feedback modality before and after the feedback period. The vertical dashed line indicates the week in December 2016 when all farmers received feedback.

- Scarcity about 50% lower after treatment are implemented
- RCT shows no differences in water savings across different treatment types
- Rolling out this simple agricultural extension information to all schemes can dramatically increase scheme efficiency

3 Key Takeaways

1

Despite high returns, providing irrigation for free to farmers does not guarantee use will be optimal—may be too high, but may be too low!

→ sustainability of the scheme may be at stake!

2

Irrigation projects cannot take a brick-and-mortar only approach

→ carefully crafted complementary interventions are crucial!

3

Allowing for projects to learn by doing is essential – costs of trial-and-adopt are paid by avoiding costly mistakes

- e.g., purchasing more pumps when information can close the water gap

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