Smallholders’ Resilience in the Eastern Gangetic Plains

A framework to support productive use of groundwater resources within sustainable limits

By Anton Urfels

1. Introduce Myself, Organization, Project
2. Overview of Study Area and Problems
3. Examples of Recent Work
4. Framework, Ongoing Work & Future Directions

Introduction: Anton Urfels
- BA Int’l Studies & MSc Int’l Water Management
- With CIMMYT South Asia Office since 2016 for MSc Thesis on Irrigation
- Currently PhD and more @ CIMMYT & WUR

Introduction: CIMMYT
- International Agricultural Research Center
- Leading Maize and Wheat Breeding Programs
- Sustainable Intensification for Smallholders
- Large Field Presence & Strong Local Partner Network

Introduction: CSISA Project
- 8 million farmers
- Multi-million dollar investment in South Asia
- Complementary Investments on climate-smart agriculture

Private Pump Irrigation (PPI) in the Eastern Gangetic Plains
- Alluvial Aquifer
- > 1000mm/yr
- PPI main source of irrigation
- Rice-Wheat Systems
- Poverty Hotspot
- >150 million people
13-02-2020

**PPI Characteristics in Nepal**

- Based on 2016 field data
- Some farmers do irrigate more than others: Why?
- Source: Urfels (under review)

###CAPEX ($)

<table>
<thead>
<tr>
<th>Type</th>
<th>Cost Range</th>
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<tbody>
<tr>
<td>Large diesel pumpsets</td>
<td>$350 - 650</td>
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<tr>
<td>Small diesel pumpsets</td>
<td>$250 - 450</td>
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<tr>
<td>Electric pumpsets</td>
<td>$150 - 250</td>
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<tr>
<td>Rented pumpsets</td>
<td>$0</td>
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###OPEX ($/h)

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<th>Type</th>
<th>Cost Range</th>
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<td>Small diesel pumpsets</td>
<td>$0.3 to $0.7</td>
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<td>Electric pumpsets</td>
<td>$0.07 to $0.12</td>
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<td>Rented pumpsets</td>
<td>$3 - $4.5</td>
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###Power (HP)

<table>
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<tr>
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<td>5 - 10</td>
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<tr>
<td>Small diesel pumpsets</td>
<td>3 - 5</td>
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<tr>
<td>Electric pumpsets</td>
<td>1.5 - 2.5</td>
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<tr>
<td>Rented pumpsets</td>
<td>3 - 10</td>
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</table>

###Mobility

- Large diesel pumpsets: Immobile, transported with bullock cart
- Small diesel pumpsets: Mobile, transported on bicycles
- Electric pumpsets: Mobile, transported on bicycles
- Rented pumpsets: Depends on rented pumpset

###Popularity for kharif rice irrigation

- Small diesel pumpsets: Low. Regarded as weak and easily damaged. $83
- Electric pumpsets: Medium. Inexpensive and efficient, but dependent on unreliable and difficult to access electricity.
- Rented pumpsets: High, but depending on availability, social capital and cash/credit availability.

**Irrigation as a Social-Ecological System**

- Irrigation is part of complex social-ecological dynamics
- Causal Loop Diagrams: Bihar, 120 people, 3 Agro-ecological Zones, 25 villages

**PPI, Decision-Making and Time**

Source: Urfels (under review)

**Critical Water Levels for PPI**

- 2018 Rice Survey
- Random Forest: Probability of Early Nursery
- ~7m max suction head for centrifugal pumps
- Comprehensive and context-specific interventions
- Collective Action?

**Planting, Irrigation and Time**

- Water availability critical for timely planting
- Why late planting if irrigation is available?

**A framework for PPI & Resilience**

- How to sustainably scale PPI to impact?

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**Perceived ideal time of irrigation**

- Start: No ponding & no cracks

<table>
<thead>
<tr>
<th>Condition</th>
<th>Percentage of respondents</th>
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<tr>
<td>Large soil cracks</td>
<td>60%</td>
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**STW queuing**

- STW delays

**Electricity/fuel availability**

- Electricity shortage
- Fuel shortage

**Liquidity delays**

- Maintenance delay
- Land access delay
- Labor shortage delay
- Maintenance delays

**Actual time of irrigation**

- Irrigation

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<tr>
<td>Small soil cracks</td>
<td>18%</td>
</tr>
<tr>
<td>No ponding</td>
<td>82%</td>
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<tr>
<td>No cracks</td>
<td>97%</td>
</tr>
<tr>
<td>No delays</td>
<td>95%</td>
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<td>14%</td>
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<tr>
<td>Small soil cracks</td>
<td>9%</td>
</tr>
<tr>
<td>No ponding</td>
<td>15%</td>
</tr>
<tr>
<td>No cracks</td>
<td>85%</td>
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**Collective Action?**

- How to sustainably scale PPI to impact?
Ongoing & Future Work

Understanding Drivers of PPI Cost
Pump Testing, Surveys Analytics, Value Chain Analysis (Manchester)
Groundwater and Irrigation Mapping
Remote Sensing Approaches (Manchester, Cornell)
Socio-Hydrological Crop Models
High-Res Gridded APSIM (CIMMYT)
Estimating Safe Operating Spaces
Scoping Use of Land Surface Models (Wageningen UR)

PPI Resilience
Field data collection
Cognitive, Behavioral Studies
Humans in modelling

What is needed?
- Solar irrigation & electrification limited in the short and mid-term
- Support longer-term switch to renewables by understanding current practices, bottlenecks and value chains
- User-centered policies and research
- Stronger Research and Development Partnerships

Thank you for listening
- Questions?
- Looking forward to further discuss during the Forum
- anton.urfels@outlook.com

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