

## Smallholders' Resilience in the Eastern Gangetic Plains

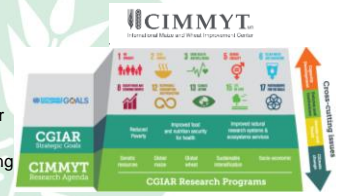
A framework to support productive use of groundwater resources within sustainable limits  
By Anton Urfels

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1-7 September 2019, Bali, Indonesia

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## Introduction: CIMMYT

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



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## Overview

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



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## Introduction: CSISA Project

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



USAID Bill & Melinda Gates Foundation CIMMYT IRRI  
CEREAL SYSTEMS INITIATIVE FOR SOUTH ASIA

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## 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

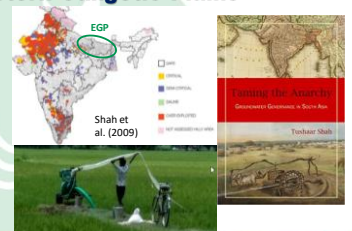


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## Private Pump Irrigation (PPI) in the Eastern Gangetic Plains

- Alluvial Aquifer
- > 1000mm/yr
- PPI main source of irrigation
- Rice-Wheat Systems
- Poverty Hotspot
- >150 million people



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### PPI Characteristics in Nepal

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

CAPEX (k)	OPEx (k/a)	Power (kW)	Mobility	Popularity for/has/ not irrigation	Potential profits per hectare (USD/ha-yr)
Large diesel pumps	\$150-650 (\$1000 a-)	\$1 to \$2 (\$1000 a-)	3-10	Highly dependent on crop and farmer status symbol.	\$17
Small diesel pumps	\$250-450 (\$2000 a-)	\$1 to \$10 (\$1000 a-)	3-5*	Medium, transported on bicycles	\$13
Electric pumps	\$107 to \$250 (\$1000 a-)	\$1 to \$2 (\$1000 a-)	1.5-2.5*	Medium, dependent on electricity availability and difficult to access.	\$13
Hand pumps	\$1-54.5 (\$1000 a-)	0	3-10	High, but dependent on availability, social capital and cultivator's availability.	\$28



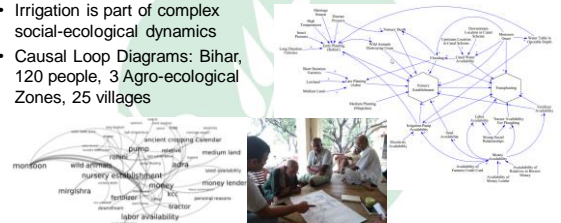
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### Irrigation as a Social-Ecological System

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



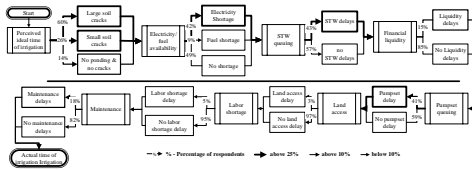
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### PPI, Decision-Making and Time

Source: Urfels (under review)



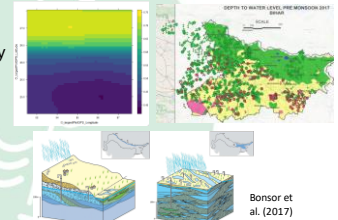
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### Critical Water Levels for PPI

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



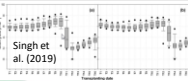
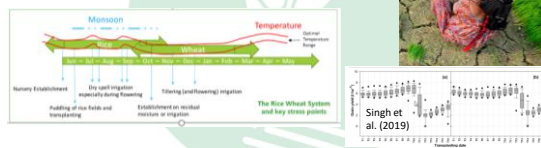
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### Planting, Irrigation and Time

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



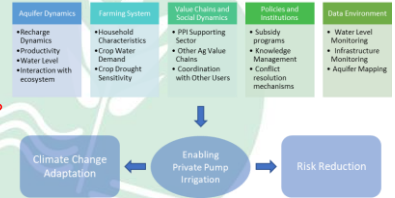
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### A framework for PPI & Resilience

- How to sustainably scale PPI to impact?



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### 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)

**PPI Resilience**

**Socio-Hydrological Crop Models**  
High-Res Gridded APSIM (CIMMYT)

**Estimating Safe Operating Spaces**  
Scoping Use of Land Surface Models (Wageningen, UR)

**SENTINEL-1**

**APSIM INITIATIVE**

**AQUACROP**

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### 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**

**Field data collection**

**Cognitive-Behavioral Studies**

**Humans in modelling**

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### Thank you for listening

- Questions?
- Looking forward to further discuss during the Forum
- [anton.ufels@outlook.com](mailto:anton.ufels@outlook.com)

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