Integrated crop water management might sustainably halve the global food gap

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RD 1: Earth System Analysis
How to accomplish food production for a growing world population while staying within the planetary boundaries?
Sustainable Development Goals: little quantitative evidence

2.1 End hunger + achieve food security
2.3 Double agricultural productivity
2.4 Sustainable food production

= ?
Options for intensification within sustainability boundaries
Hydroclimatic opportunities

Transpiration

Rain and irrigation water

100%

100%

Seepage and lateral runo

16%

16%

Evaporation

33%

46%

30%

23%

Surface runo

27%

26%

Rain and irrigation water

100%

100%

(Jägermeyr et al. 2016, ERL)
Global significance of integrated crop water management
Global significance of integrated crop water management

What could be the contribution of smart water management to closing the global food gap by 2050?
Water management opportunities

- **Soil moisture conservation (SMC)**
  Reduction of non-beneficial soil evaporation
Water management opportunities

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- **Rainwater harvesting (WH)**
  Collection of surface runoff and maximizing soil infiltration
Water management opportunities

- **Soil moisture conservation (SMC)**
  reduction of non-beneficial soil evaporation

- **Rainwater harvesting (WH)**
  Collection of surface runoff and maximizing soil infiltration

- **Irrigation improvement and expansion**
  with thus saved water
LPJmL – dynamic global biosphere model

0.5° grid cells

12 crop functional types

Dynamic irrigation efficiencies

(Fader et al. 2010, Jägermeyr et al. 2015)
LPJmL – new mechanistic irrigation

(Jägermeyer et al. 2015, HESS)
LPJmL – dynamic global biosphere model

0.5° grid cells

12 crop functional types

Dynamic irrigation efficiencies

Upstream – downstream effects

(Fader et al. 2010, Jägermeyr et al. 2015)
Simulation protocol and scenario set up

1980-2009
(CRU TS 3.1 climate data)

Actual
Current management calibrated with FAO data

Σ = 688 Model simulations

(Jägermeyr et al. 2016, ERL)
Rainfed systems
Soil moisture conservation and rainwater harvesting

Soil moisture conservation: 50%

Rainwater harvesting: 50%

+7%

+18%
Potential of irrigation water savings

Jägermeyr et al. (2015), Water savings potentials of irrigation systems: global simulation of processes and linkages, HESS.
Expansion of irrigation with saved water

Irrigation improvement (Irrigated production) vs. Irrigation impr. and expansion (Total cropland prod.)

Expansion into rain-fed cropland only

Kcal production [% change]

Consumptive losses [% change]
Integrated crop water management
“ambitious” options combined

+40% global kcal

→ No land expansion
→ Reduced water abstraction
Closing the water gap

Rainfed water gap could be closed by 60%
Climate Change impacts on yields

- Climate change scenario
  - RCP 8.5, 2070-2099
  - Median of 20 GCMs
  - Moderate CO₂ fertilization

- “Ambitious” scenario:
  +35% to +42% kcal production depending on RCP scenario
Conclusions

At the global level, integrated crop water management can…

• Ease local water scarcity
• Boost yield production significantly without using additional water or land resources
• Close the water related yield gap
• Buffer potential negative climate change impacts
• Come with important co-benefits
Only fully **integrated farm management** can tap whole potential of sustainable intensification
Thank you.

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References