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# Irrigation Efficiency: Broadening the Toolbox

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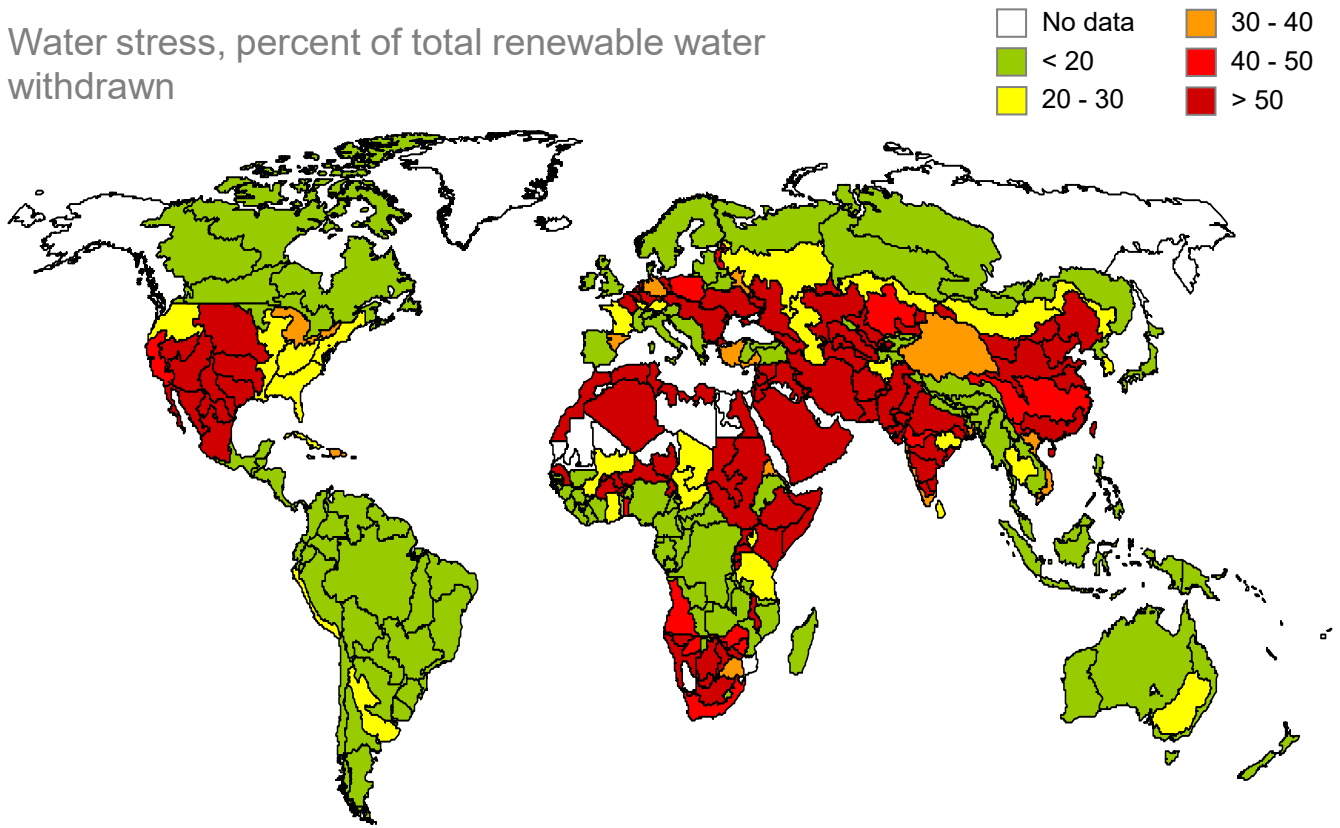
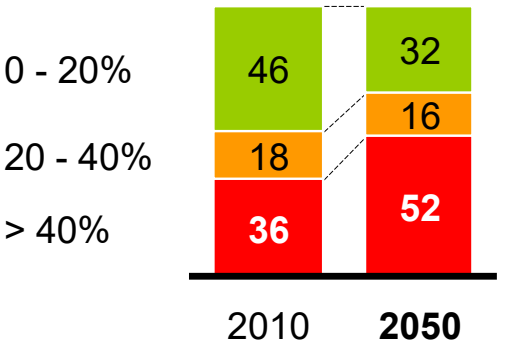
# Irrigation Efficiency: Why and How?

# By 2050, under BAU and medium growth, 52% of population and 45% of GDP are in regions at risk due to water stress

## Business as usual (BAU) water productivity, medium growth, 2050

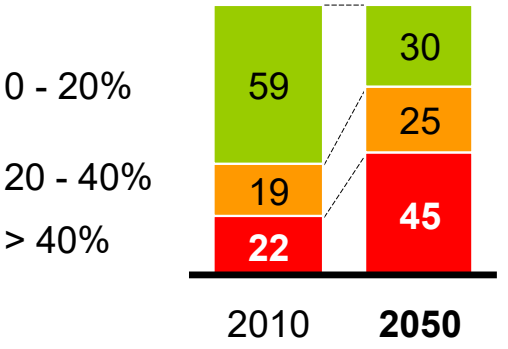



### How many people live in water short areas?




- 4.7 Bn people, 70% of 2010 pop.
- Increase by 90% compared to 2010

### How much GDP is generated in water scarce regions?




- 63 trillion USD[2] 1.5 x 2010 total GDP
- Increase by 570% compared to 2010

Ringler et al. (2016)

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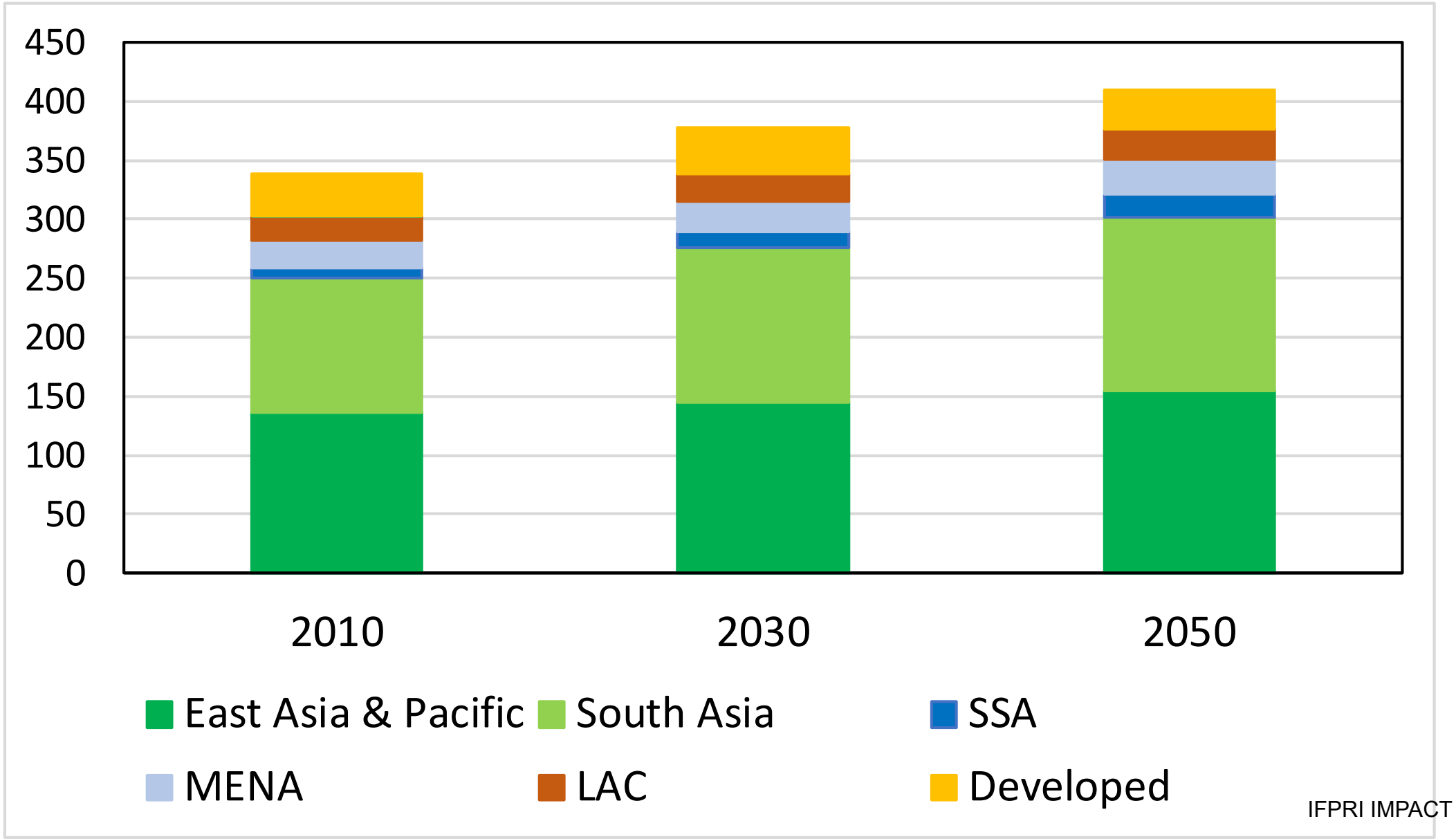
# Irrigated area is projected to continue to grow, to address CC/CV and land shortages [projections in m ha]

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# Concepts of Irrigation Use Efficiency

$$\text{Classical Irrig Efficiency [IE]} = \frac{\text{beneficial crop ET}}{\text{water delivered to the field}}$$

$$\text{Effective IE} = \frac{\text{beneficial crop ET}}{\text{water delivered to the field} - \text{return flows}}$$

$$\text{Economic Effective IE} = \frac{\text{net profits}}{\text{water delivered to the field} - \text{return flows}}$$

Keller and Keller (1995)

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# How can we improve classical (physical) irrigation efficiency?

Flood

Furrow

Sprinkler

Drip

~30% ~60% ~70% ~90%

Efficiency levels

Share area under drip & sprinkler: ~ 20% globally (ICID estimate)

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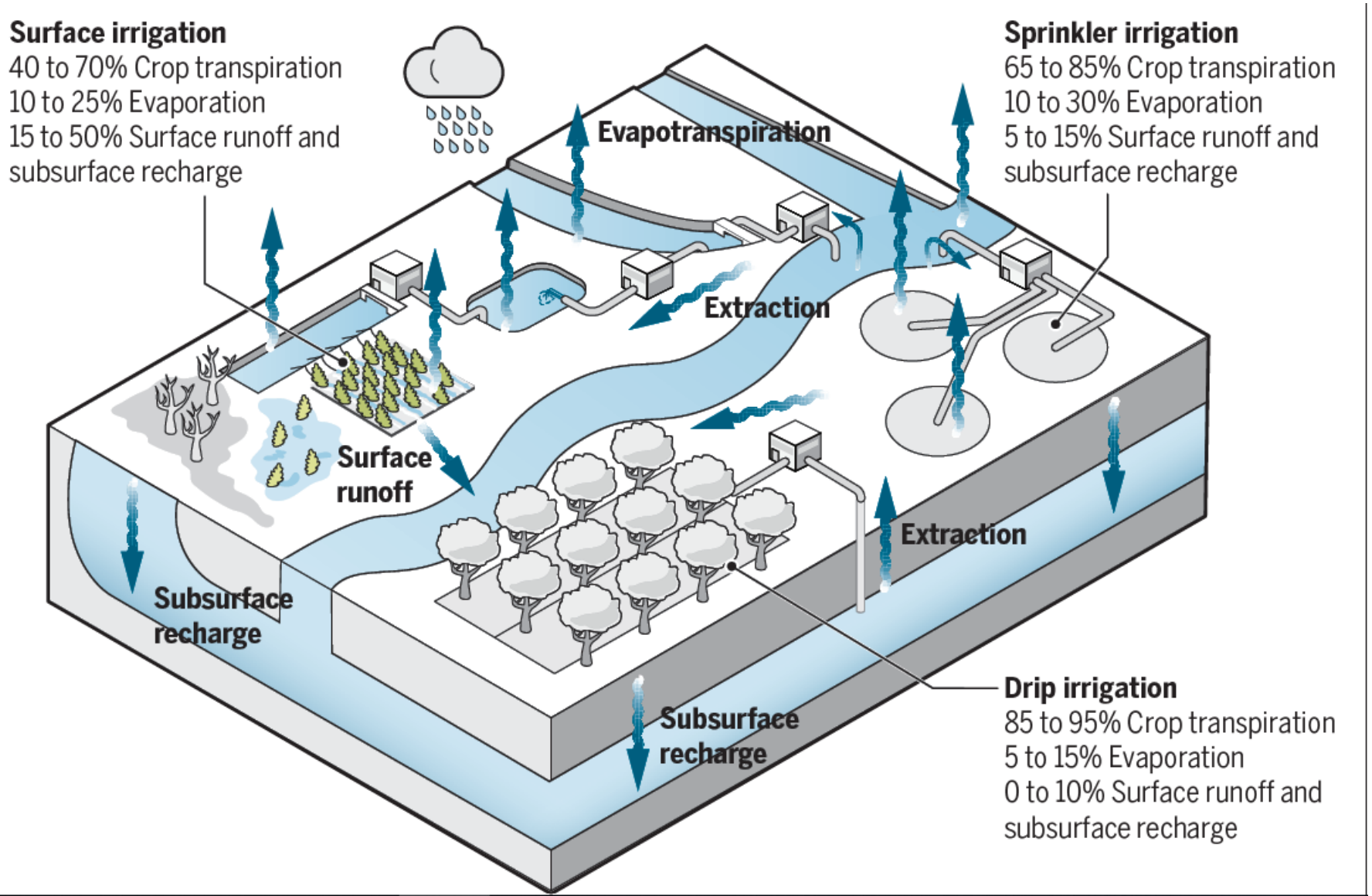
# Example MDB, Australia: How a plan to accelerate instream flows improvements through improving IE became expensive

- Background: Excessive over-allocation of available water resources, dying riverine ecology, 'Millennium Drought'
- Response: "Water for the Future Plan": AUD3.1 billion to directly buy water entitlements from willing sellers; and AUS5.8 billion in subsidies for water infrastructure [with neutral or improved socioeconomic impacts]
- Cost of irrigation subsidies: ~AUD12,5/$m^3$ compared to ~AUD 2/$m^3$ for buy-back of water rights due to the non-linearity of water savings from irrigation infrastructure investment

# The Paradox of Irrigation Efficiency: IE & water consumption increase




Grafton et al. 2018

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# How to ensure that improved IE not only supports agricultural production but also river flows/ other uses

- Understand water flows, particularly return flows and their uses, before introducing advanced irrigation systems [through RS of ET]
- Use simple to complex measures to measure how much irrigation is needed [wetting front detectors to soil moisture sensors that trigger remotely controlled operation of irrigation, including in Egypt]
- If the goal is to conserve water resources, then a reduction on withdrawals should be introduced together with advanced technologies [or withdrawals can be calculated as net extractions, already accounting for return flow, or charges on return flow reductions could be imposed, etc.]
- Behavioral change of irrigators needs to be understood
- Uncertainty in weather and flows needs to be factored in

Grafton et al. 2018

# Other ways to improve water use efficiency

# The many ways to improve water use efficiency beyond direct irrigation interventions

- Semi-dwarf, short duration varieties [image] use less water for the same or higher grain yield
- Drought/heat stress tolerant varieties mature under more extreme climates
- Improve value chains and cold storage--Reduce Post-Harvest Losses
- Improved water governance—Presence in the Indus Basin Irrigation System improved agricultural productivity of tailend farmers by 10%

Mekonnen et al. 2015; Rosegrant et al. 2009

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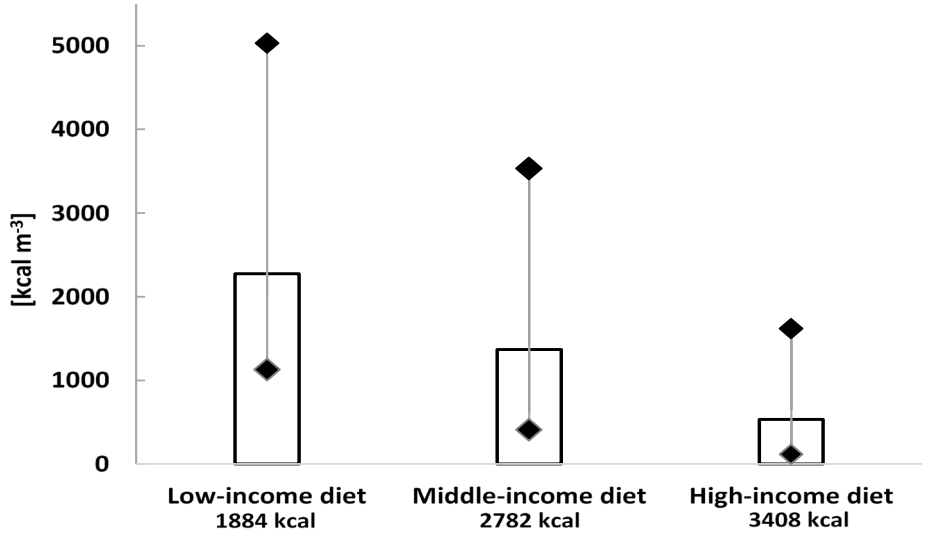
# The many ways to improve water use efficiency beyond direct irrigation interventions

- Consider support to informal water markets for better water allocation
- Paying farmers to use less water [rather than charging them for water]
- Increase profits through growing fish in irrigation systems
- WUE should not be considered without impacts on GHG emissions and energy use efficiency—drip depends on reliable energy & water; other inputs essential for optimal yield as well
- Calculation of salt & toxic pollutant accumulation as a result of IE
- Calculate dietary water productivity [image]




McCartney et al.2019; Lundqvist et al. 2019; ADB 2017

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