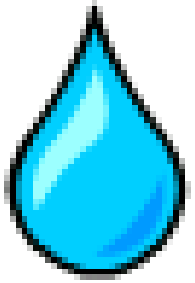
TOO MUCH OR TOO LITTLE WATER?
Engineering innovation for agricultural water management in a changing climate.

Land use and hydrology in semi-arid environments

John Gowing
School of Agriculture, Food & Rural Development
Newcastle University



Too much or too little?



….. or just enough



Let’s talk about water productivity and tools for water management

IAgrE

Weathering the Perfect Storm



The Role of Soil and Water Management

Richard Godwin







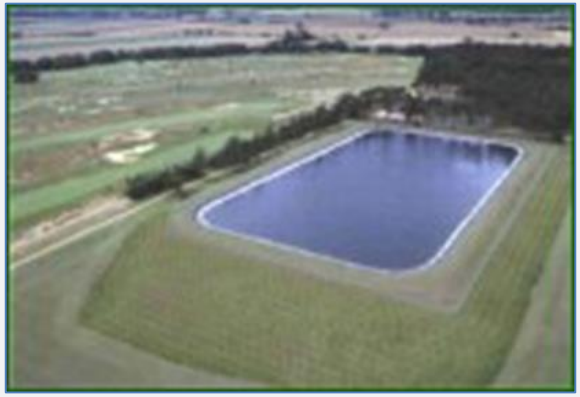
Weathering the Perfect Storm



Irrigation and water supply issues:

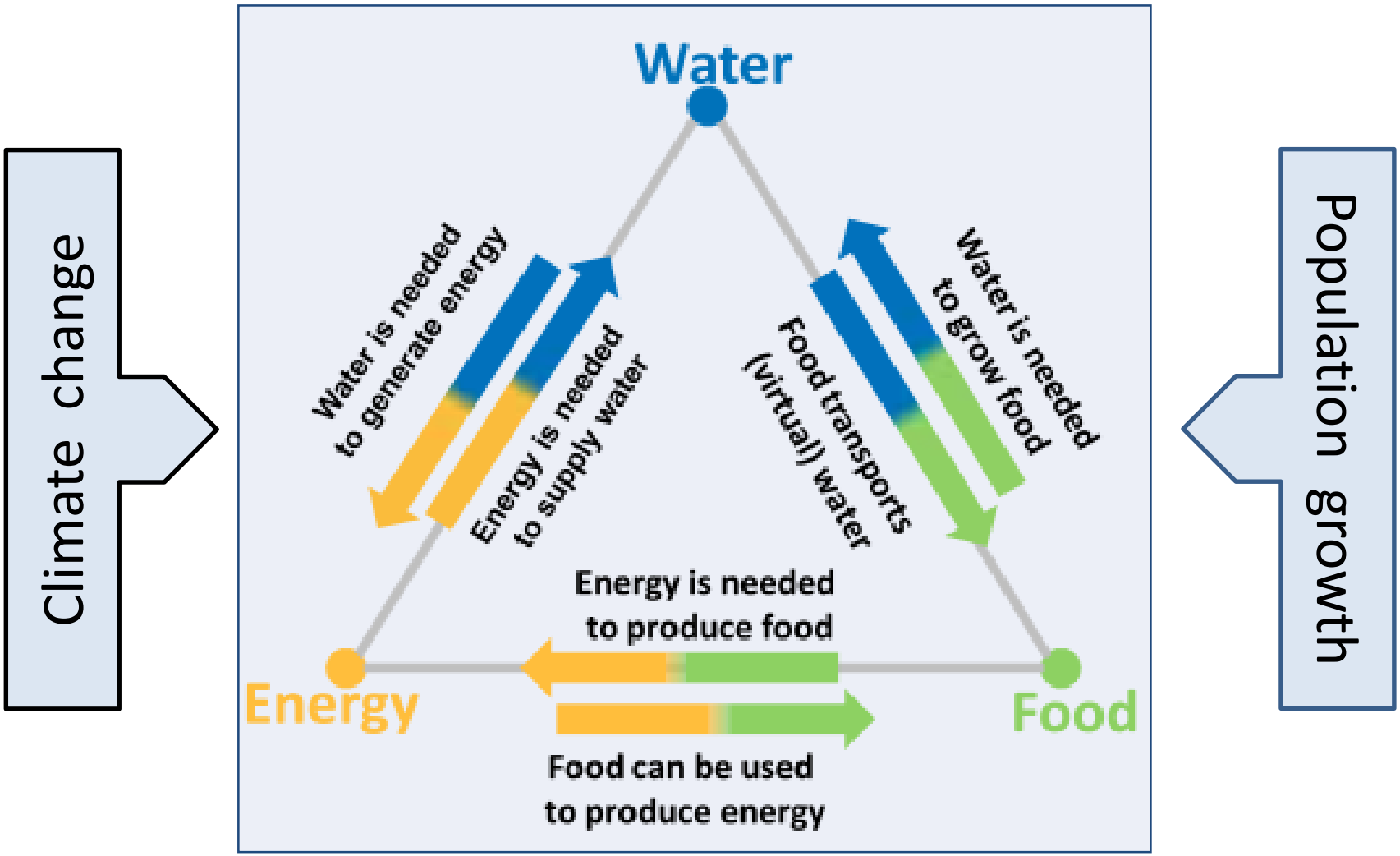
- Minimise water use
- Link irrigation to soil variability
- Develop smarter emitters (trickle systems)
- Increase uniformity and accuracy
- Recycle grey water
- Increase on-farm water storage







Water-Food-Energy Nexus



Key developments



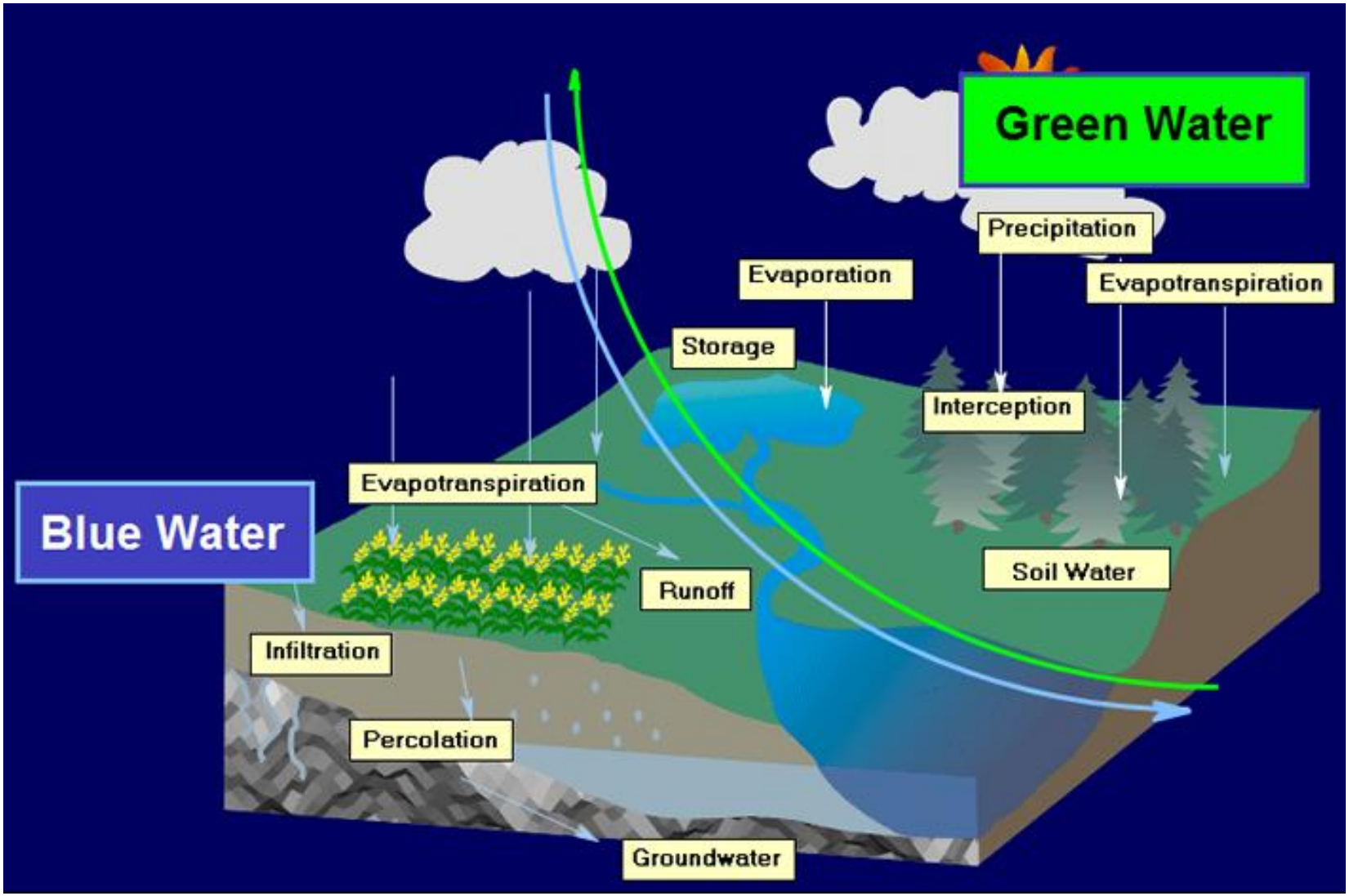
1. Sustainability paradigm – triple bottom line
2. Blue water / green water paradigm
3. Rainwater harvesting
4. Environmental economics - ecosystem services
5. Environmental flows
6. Remote sensing
7. Information technology
8. Water pricing – more crop per drop
9. Irrigation management transfer
10. Groundwater irrigation

What is missing?



1. Sustainability paradigm – triple bottom line
2. Blue water / green water paradigm
3. Rainwater harvesting
4. Environmental economics - ecosystem services
5. Environmental flows
6. Remote sensing
7. Information technology
8. Water pricing – more crop per drop
9. Irrigation management transfer
10. Groundwater irrigation

Blue water vs Green water paradigm





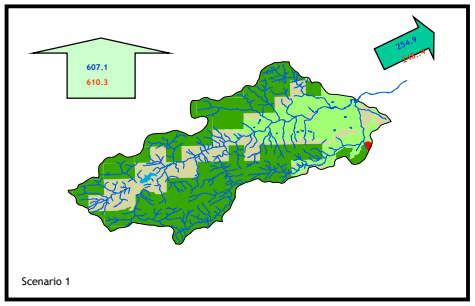
South Africa: streamflow reduction activities

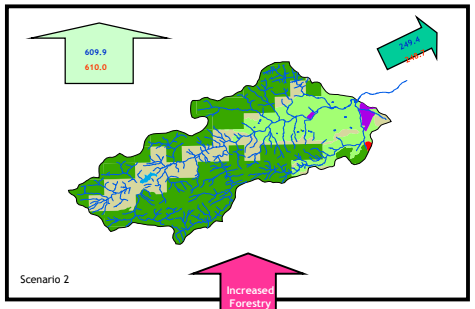


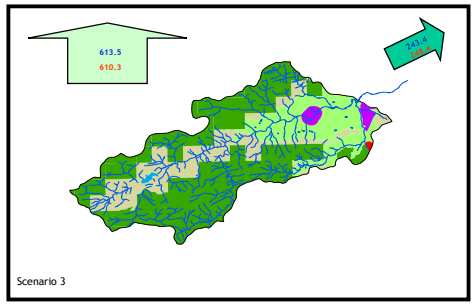
Limit commercial forestry to reduce green water flow

Release blue water flow for small-scale irrigated agriculture

Green/blue water paradigm: South Africa experience

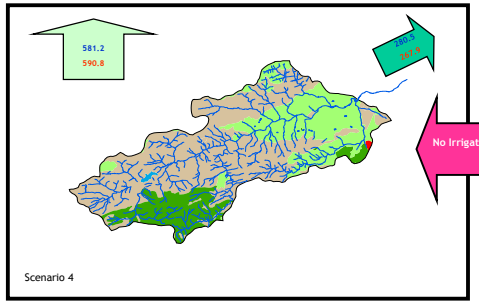




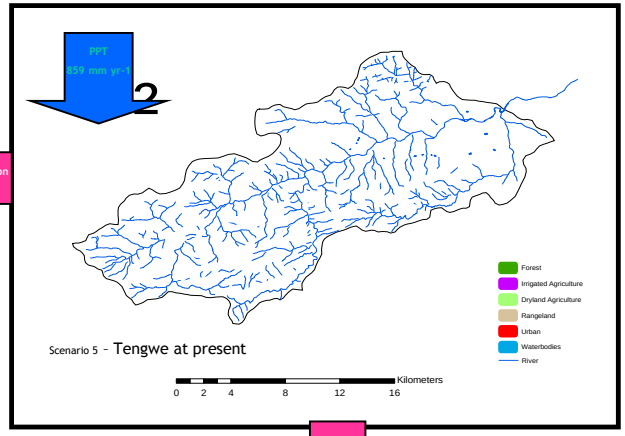


FIGURES: HYLUC ACRU

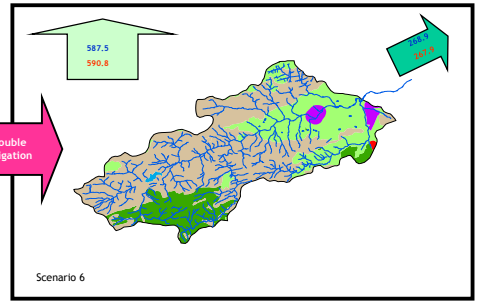
Increased Forestry



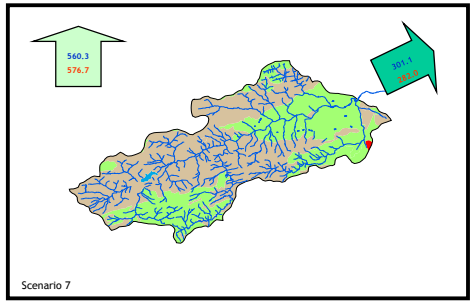
No Irrigation

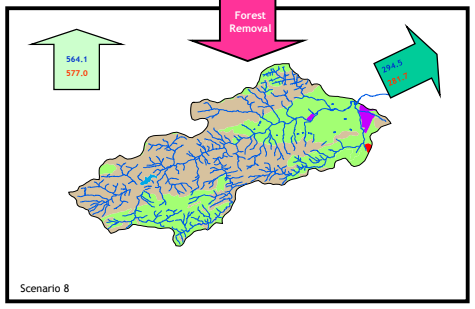


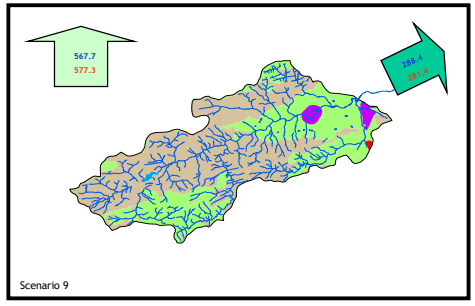
Double Irrigation

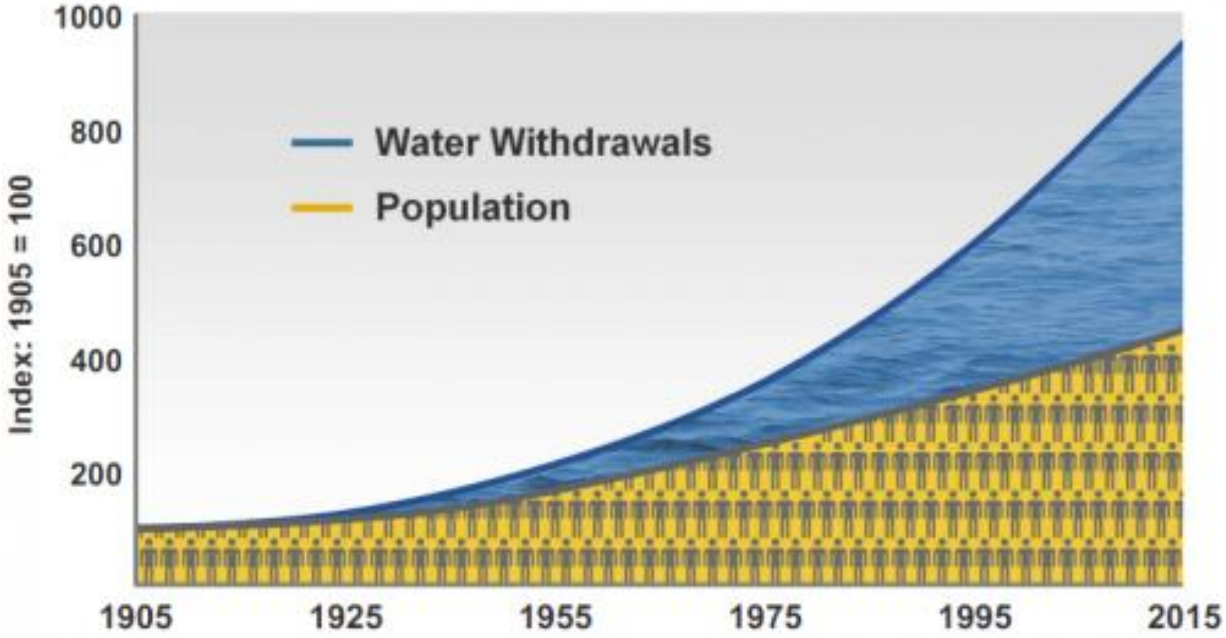


Forest Removal

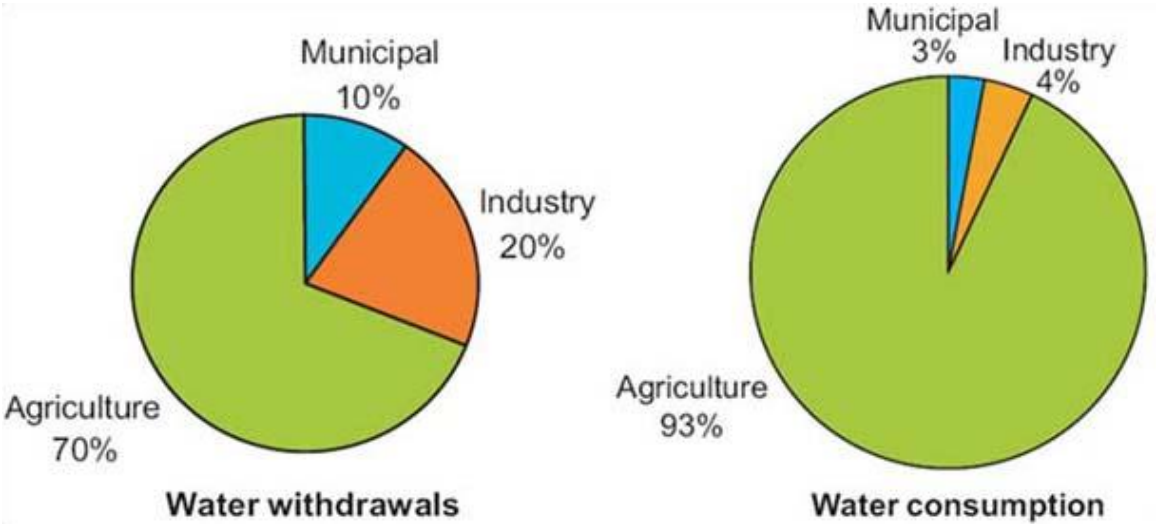




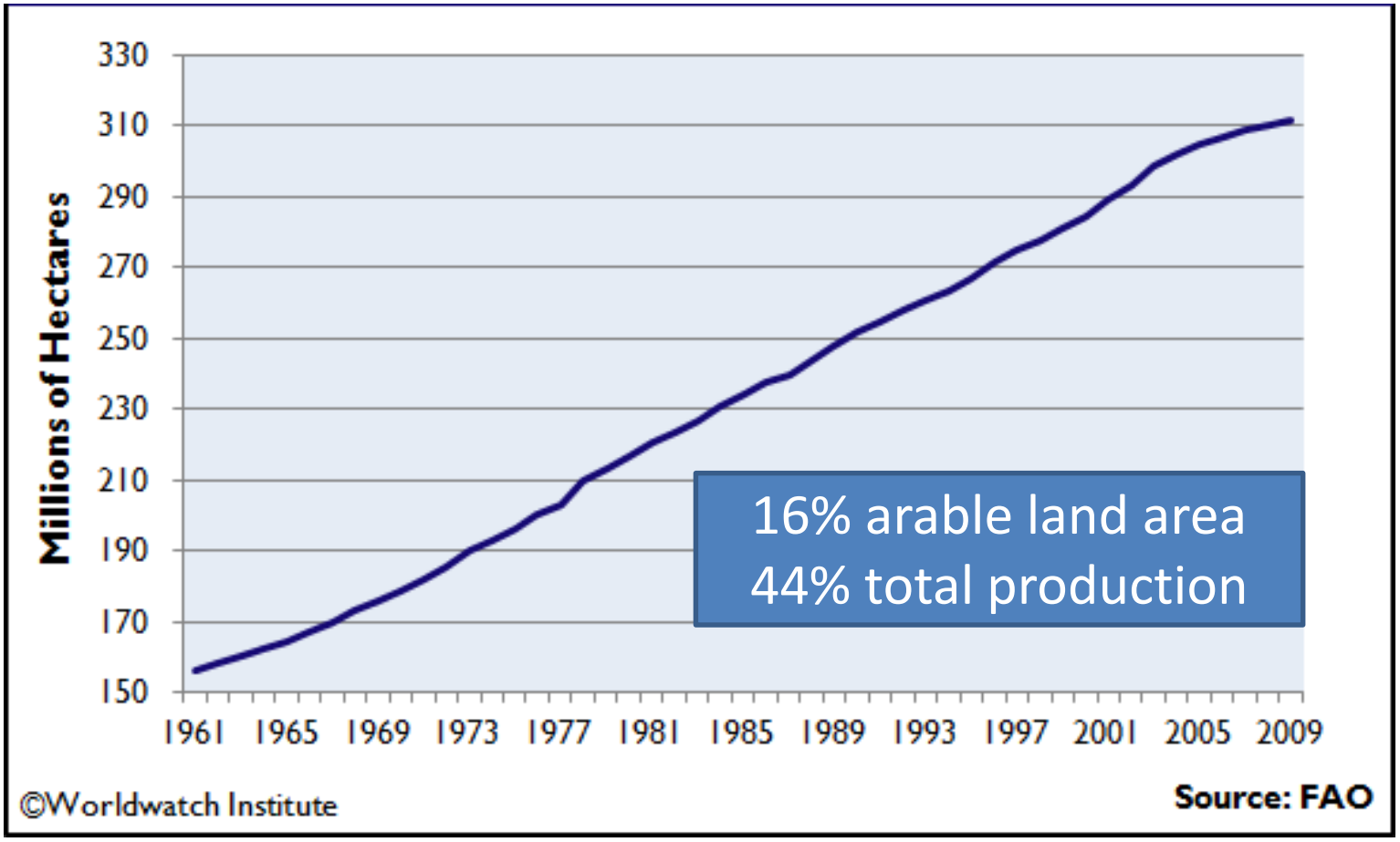



1000
800
600
400
200
Index: 1905 = 100
Water Withdrawals
Population
1905
1925
1955
1975
1995
2015

Blue water

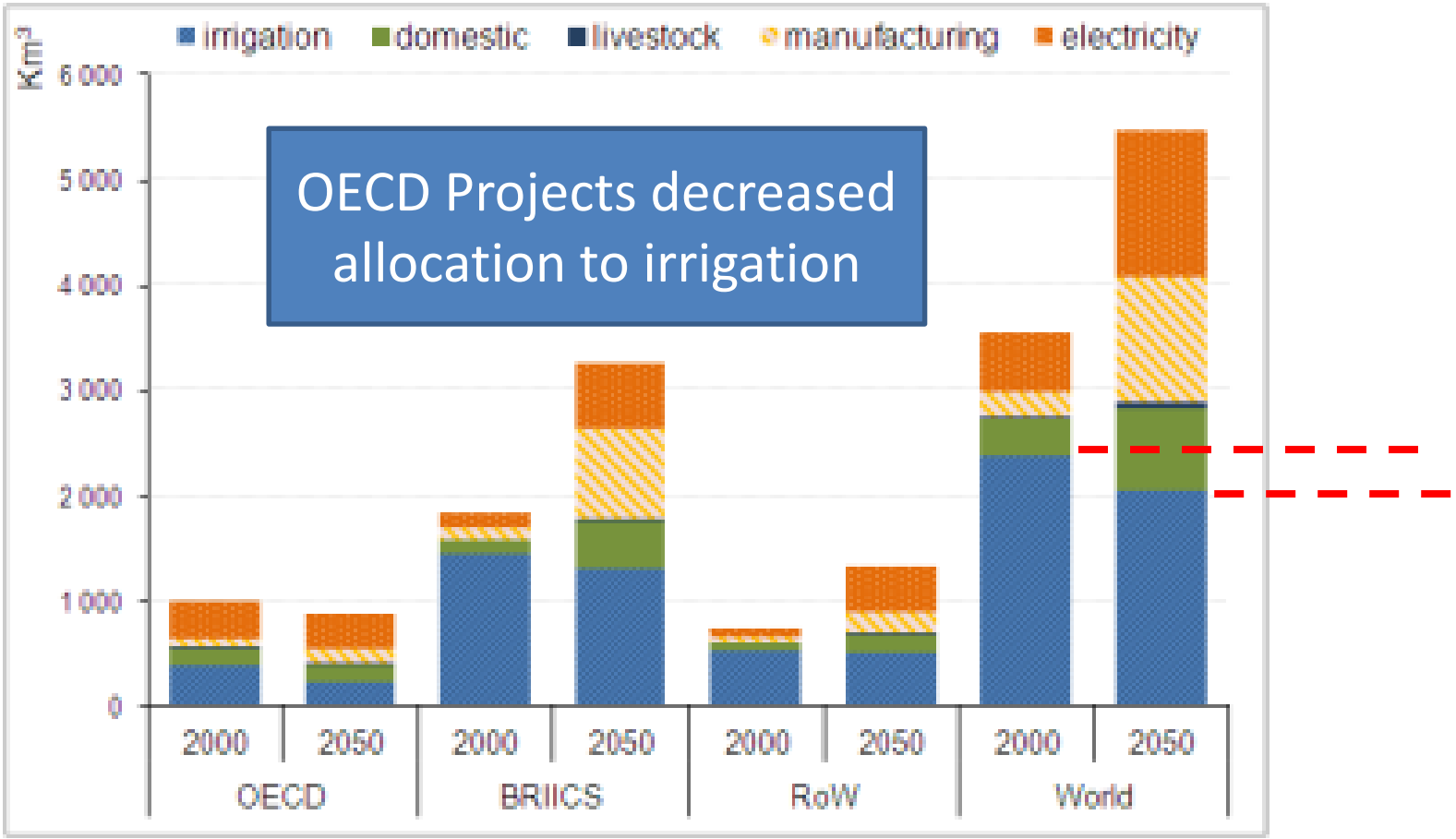

Municipal
10%
Industry
20%
Agriculture
70%
Water withdrawals
Municipal
3%
Industry
4%
Agriculture
93%
Water consumption

Global data on irrigated area



Area equipped = 310; Area irrigated = 260; Area harvested = 350

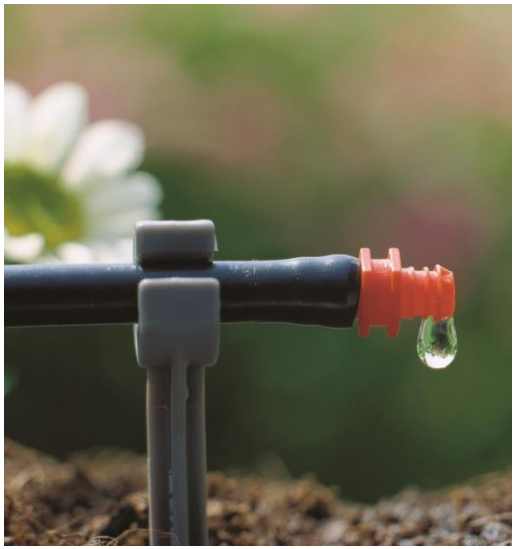
Global water use (blue water)



OECD Environmental Outlook to 2050

What technical solutions will deliver?

- Drip & sprinkler
- Supplementary irrigation
- Scheduling
- Deficit irrigation







Typical irrigation efficiency values

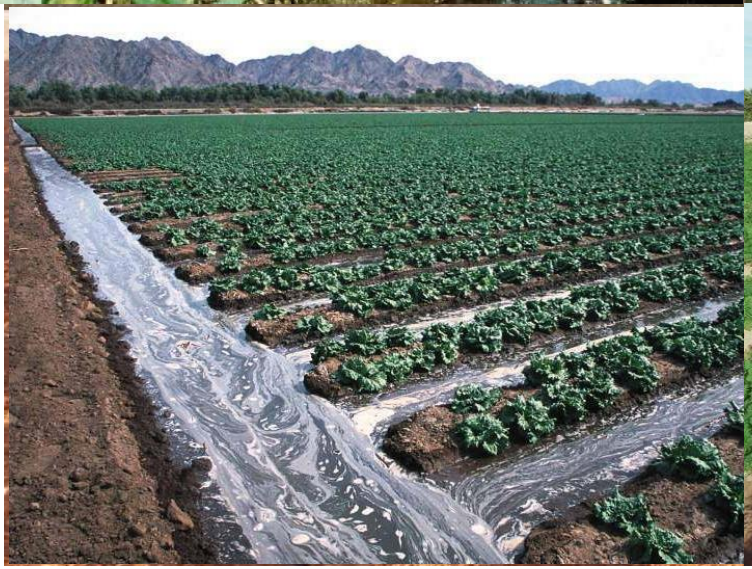
Technique	Efficiency (%)	Percolation loss (%)	Runoff loss (%)	Energy cost
Long furrow	60	20	20	
Short furrow	70	15	15	
Gated pipe	70	15	15	
T/W recovery	80	15	5	√
Sprinkler	80	10	10	√
Drip	90	10	0	√

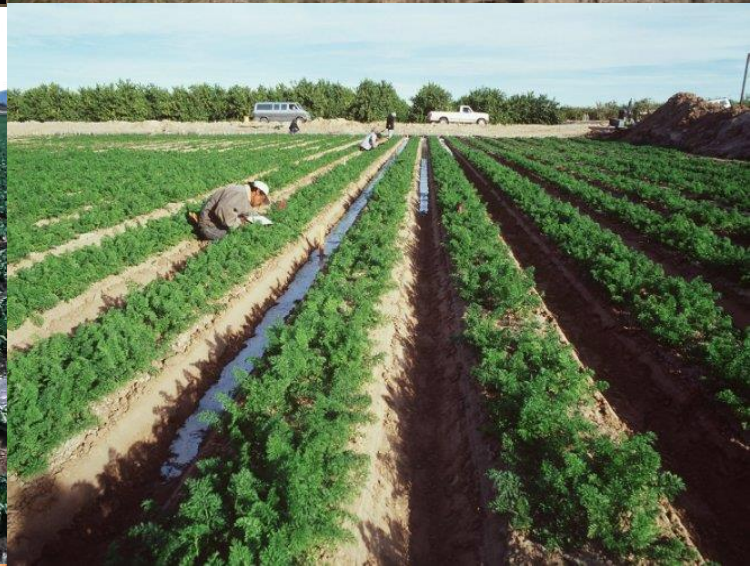
T/W = tail-water (usually associated with furrow irrigation)

This is on-farm application efficiency









Most farmers depend on canal systems







- Farmer does not control water supply
- High productivity requires water on-demand

Canal system constraints

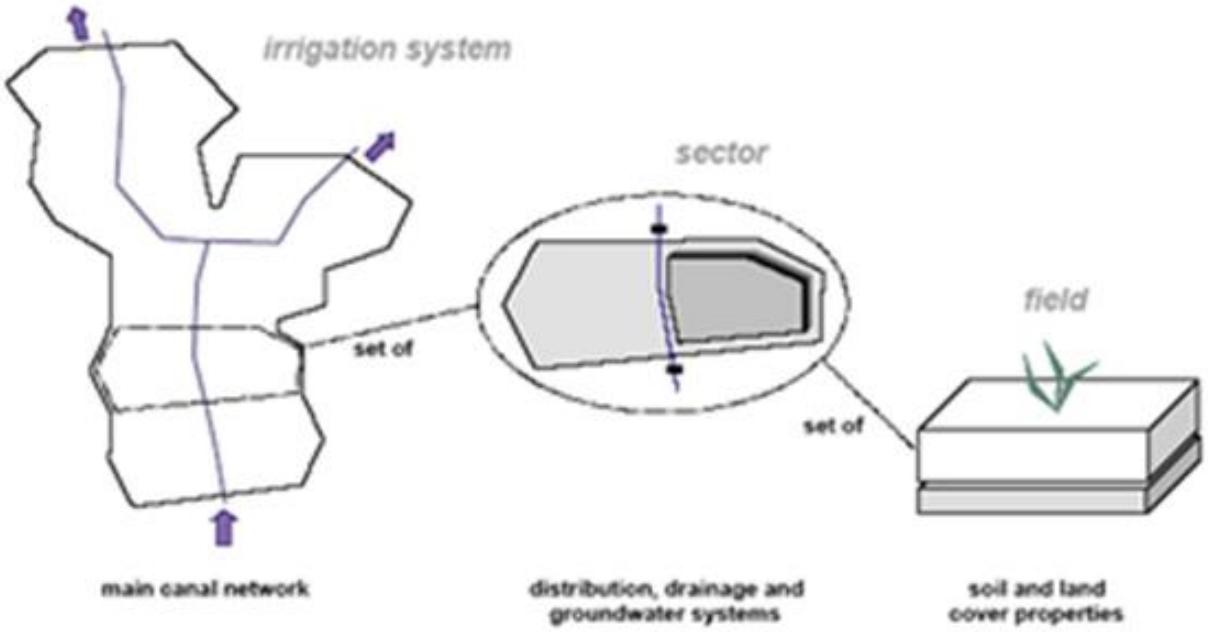






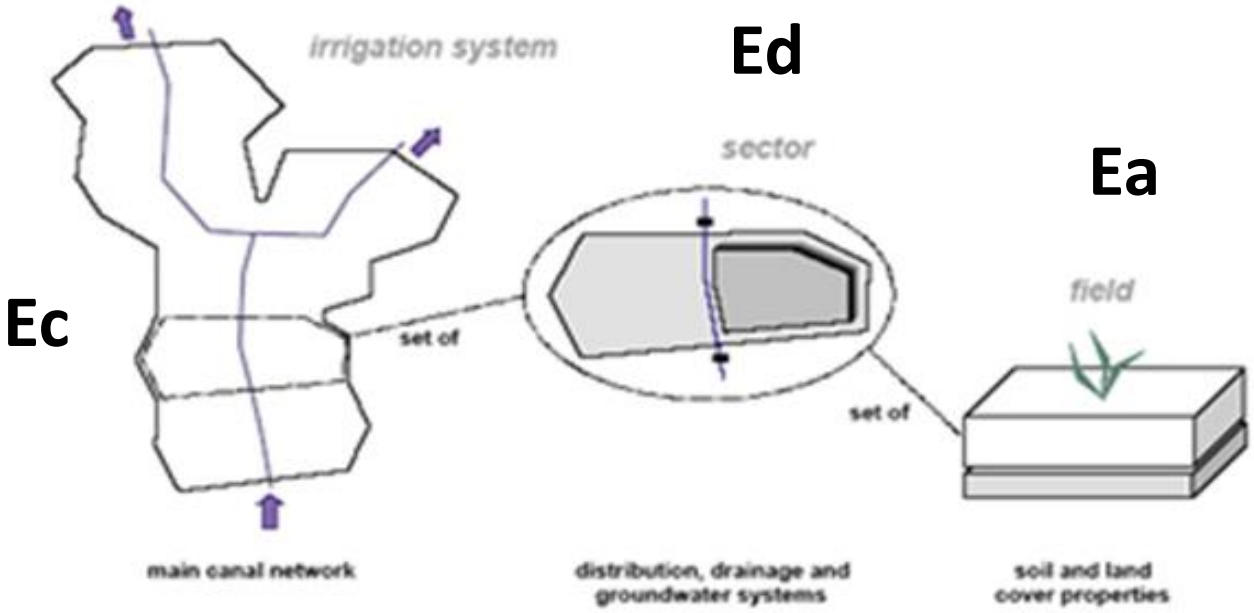


Standardisation of irrigation efficiency measures started with Bos in 1974



Ep = Ea x Ed x Ec

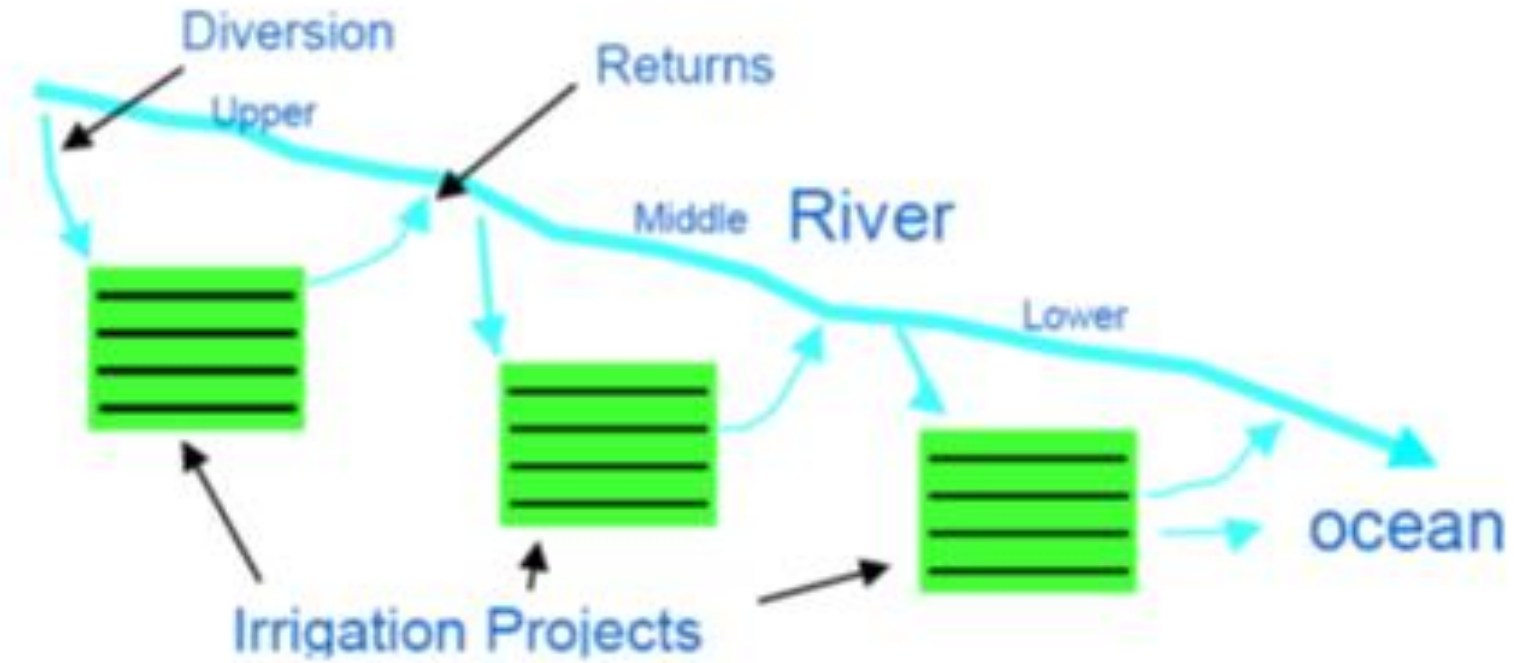
Based on typical values for these measures:



Ep = Ea x Ed x Ec

0.7 x 0.9 x 0.8 = 0.5

In the Nile valley as in many other irrigated river basins drainage water is returned and reused





Canal lining will not always deliver real efficiency gains



But it may reduce pumping for drainage re-use

Canal system constraints

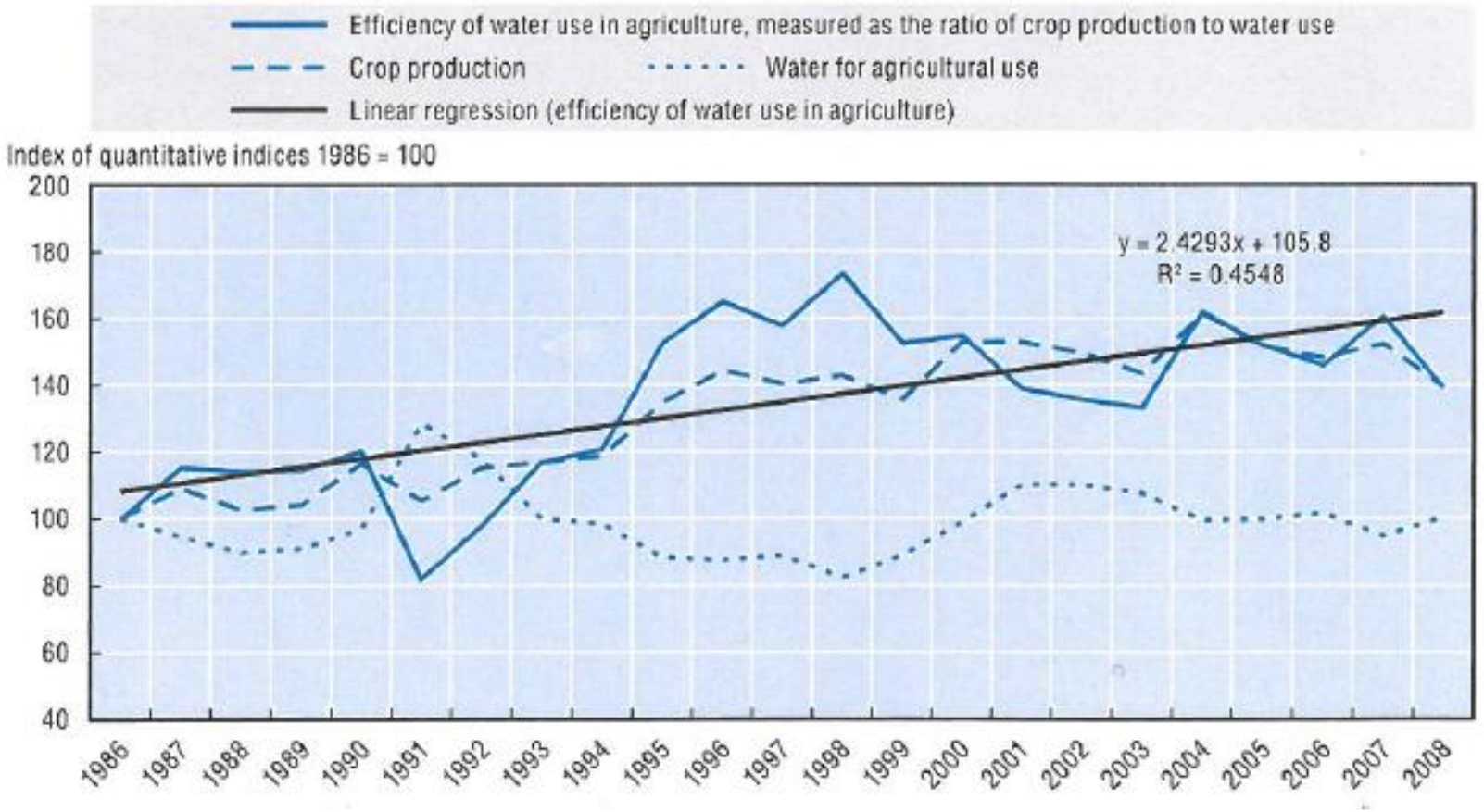


Not possible to measure supply to individual farmer



Advances in telemetry using mobile phone network may help

Evidence of progress: Israel



Source: OECD, 2010

Water reuse study in Saudi Arabia



Three sources of water at Al Hassa

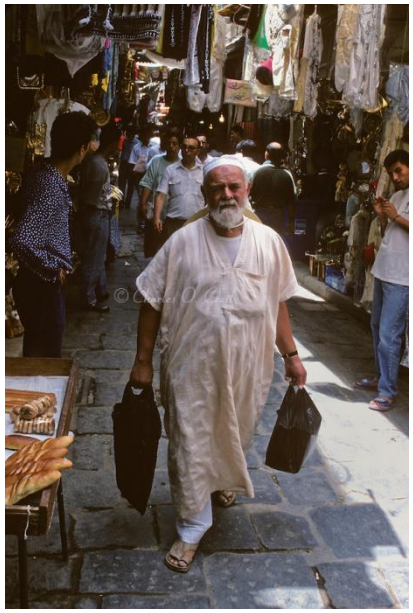


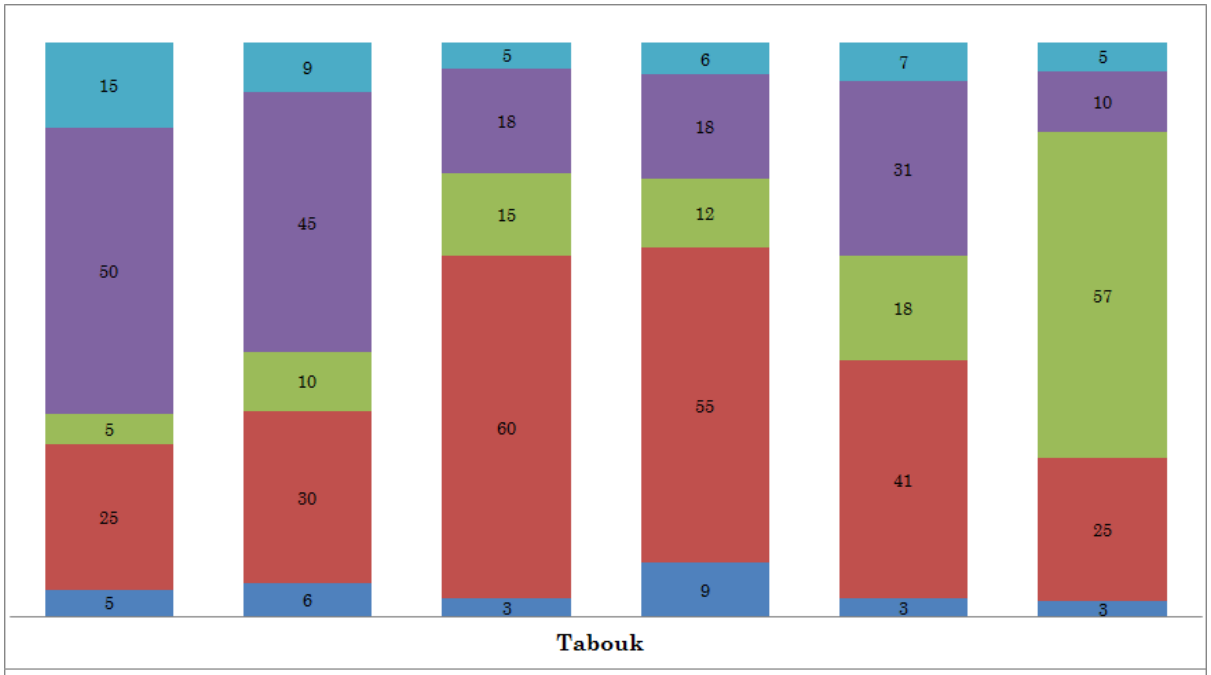
A: Urban wastewater is treated

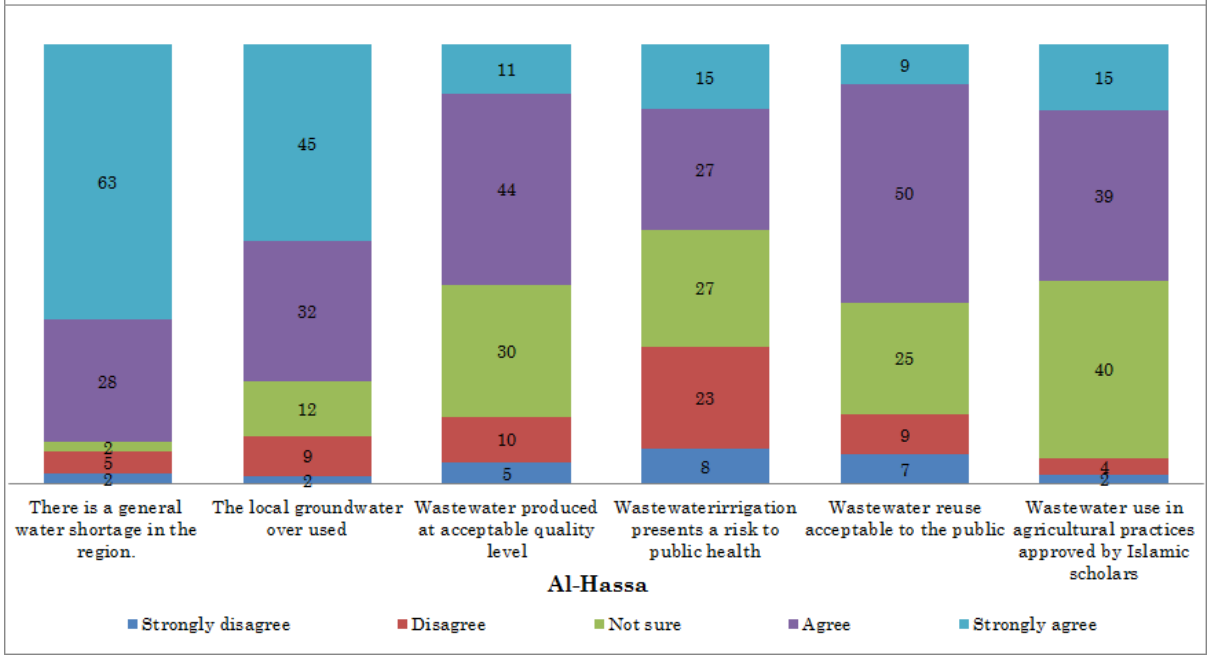
Recycled drainage water is untreated : C



Opinion survey





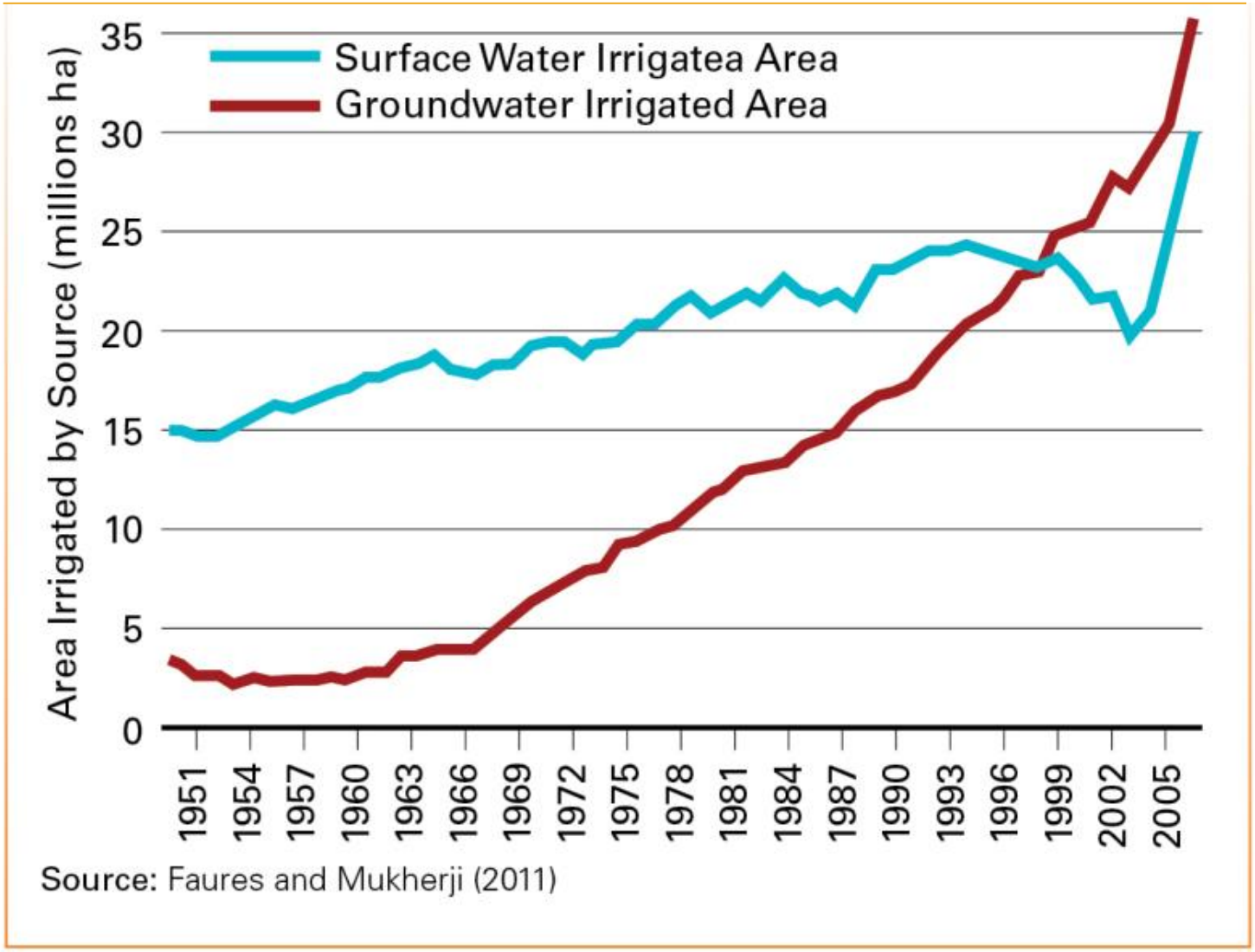


London water = reused wastewater





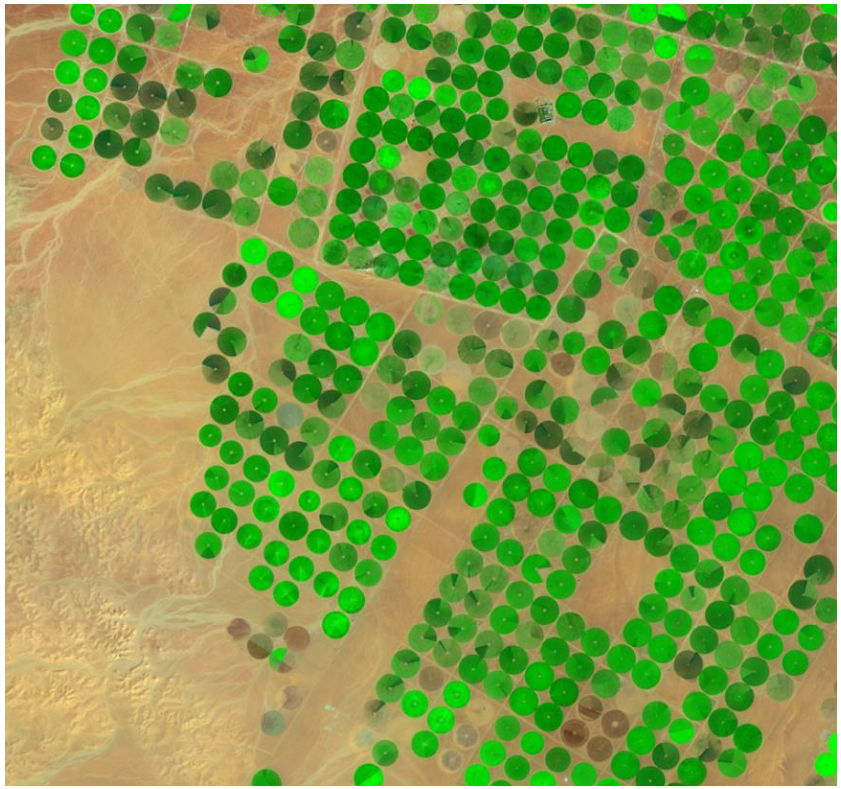
Groundwater irrigation in India



Peak Water:
What Happens When the Wells Go Dry?

18 countries, containing half the world's population, are over-pumping their aquifers.

Among these are the big three grain producers—China, India and USA.



AMGRAF: groundwater irrigation in Ethiopia

- limited by energy for water-lifting
- Well yields are low (typically 1 l/s)

Region	Groundwater irrigation	
	Mha	% total area
South Asia	48.3	57
East Asia	19.3	29
South-East Asia	1.0	5
MENA	12.9	43
Latin America	2.5	18
SSA	**0.4**	**6**



Green water

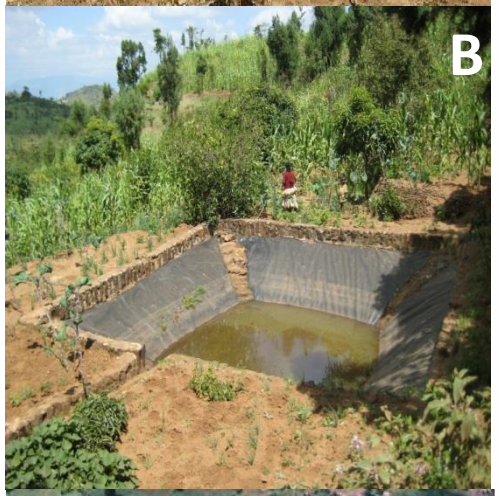
- 86% arable area; 56% total production



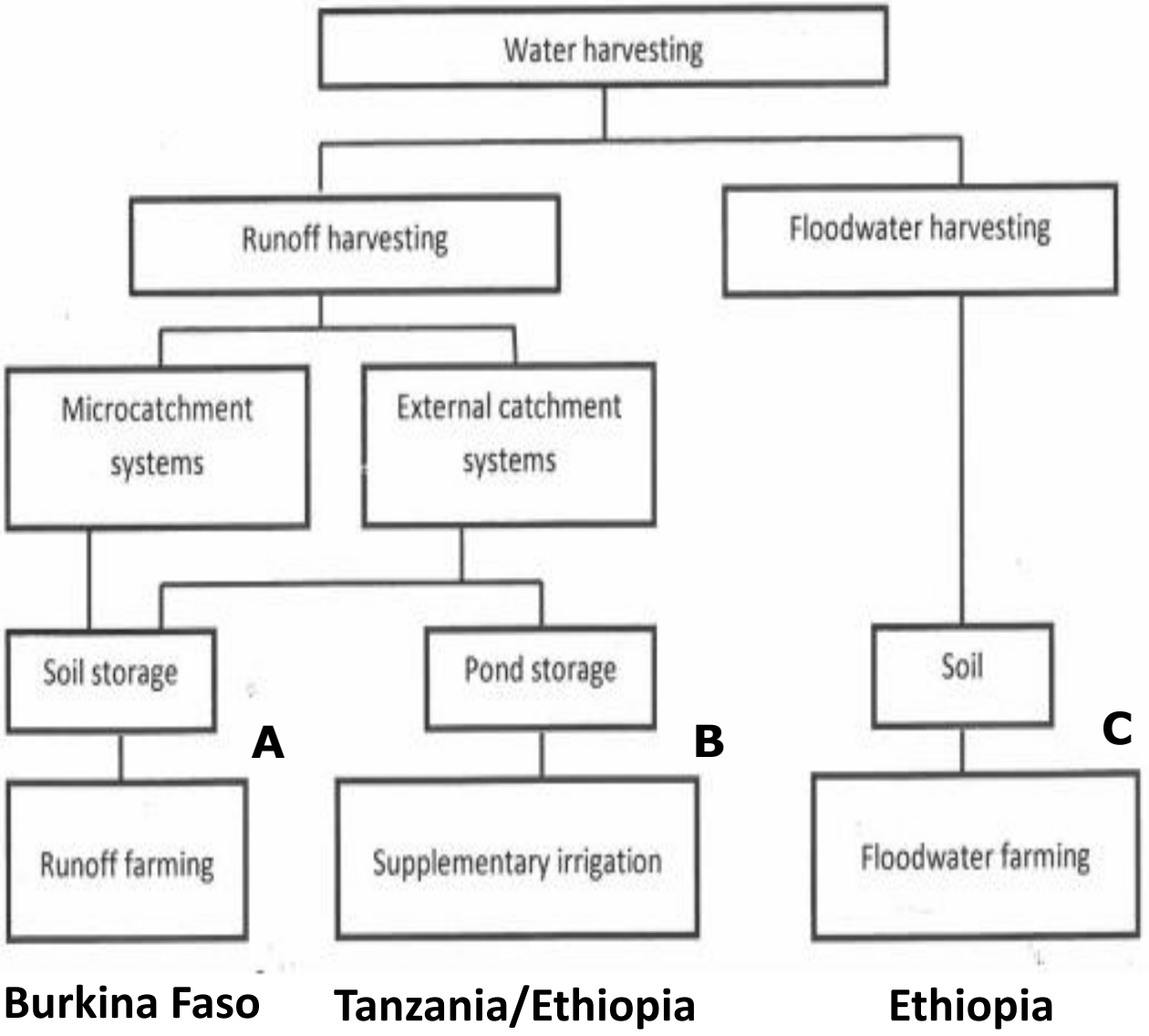


Water harvesting in sub-Saharan Africa









Conclusion: water productivity challenge

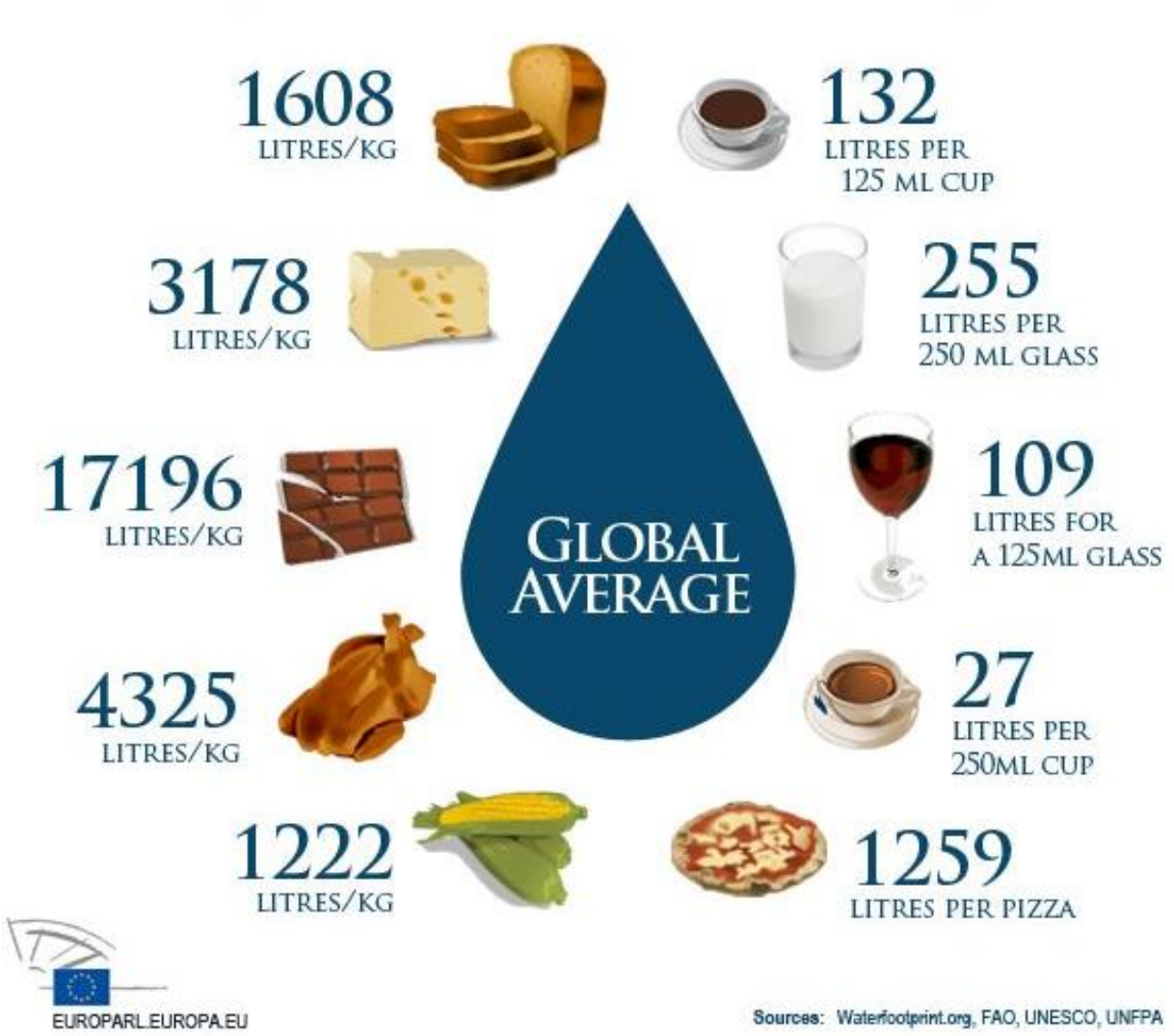
- In closed basins we have to achieve more with less blue water
- Technical solutions can target non-beneficial consumption
- Technical solutions can target new supplies

  eg. treated wastewater & saline groundwater
- Not clear that these can be achieved without increased energy use

Conclusion: water productivity challenge

- Faced with blue water scarcity we need to target increased productivity of green water
- Semi-arid dryland cropping systems are constrained by risk
- Adoption not likely to be spontaneous
- Technical capacity constraints
- Beware: success with green water can translate into reduced availability of blue water

Water productivity: water footprint



The end





Thank you
for
listening