



Alternate partial root-zone irrigation: a novel irrigation strategy improves resource use efficiency and product quality

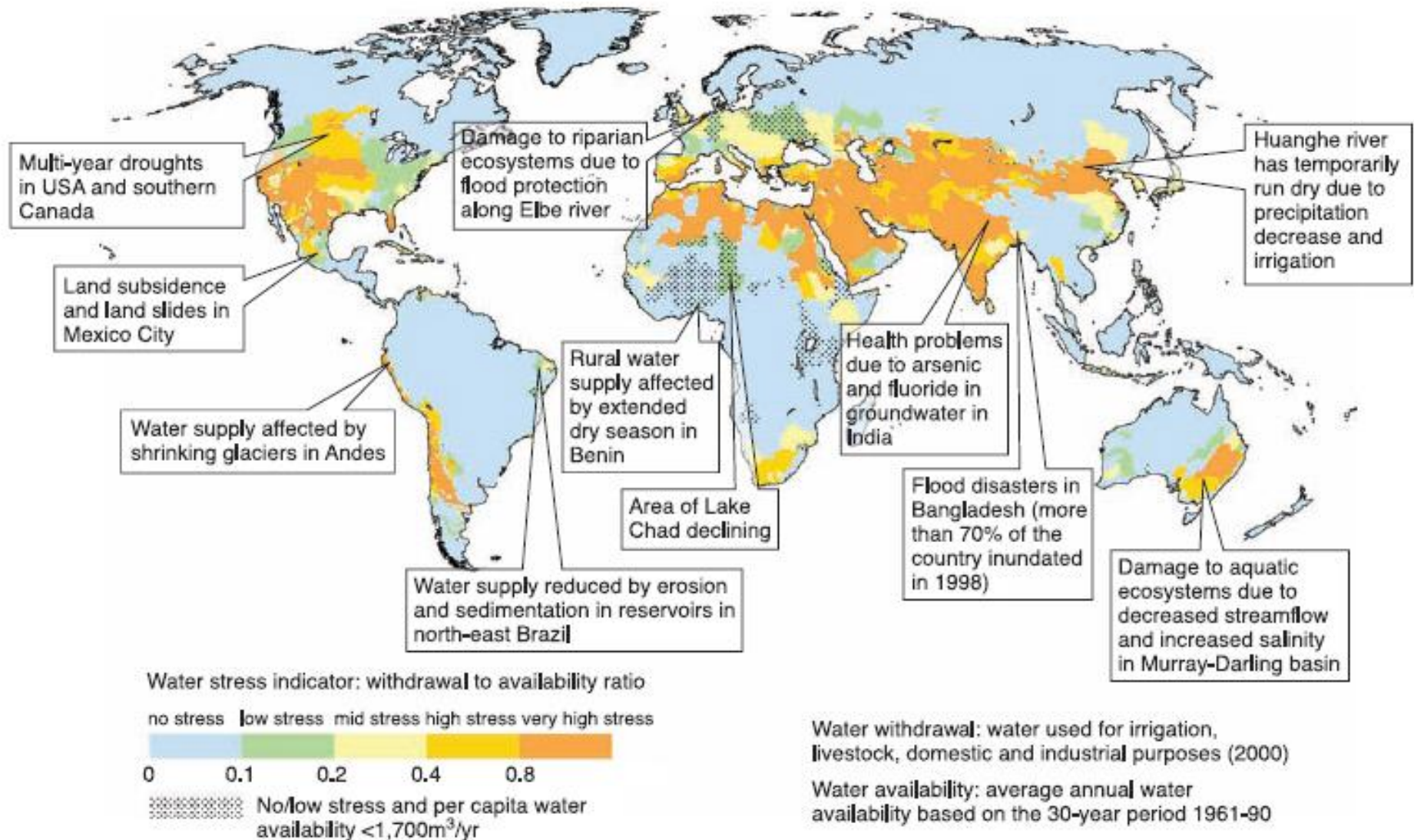
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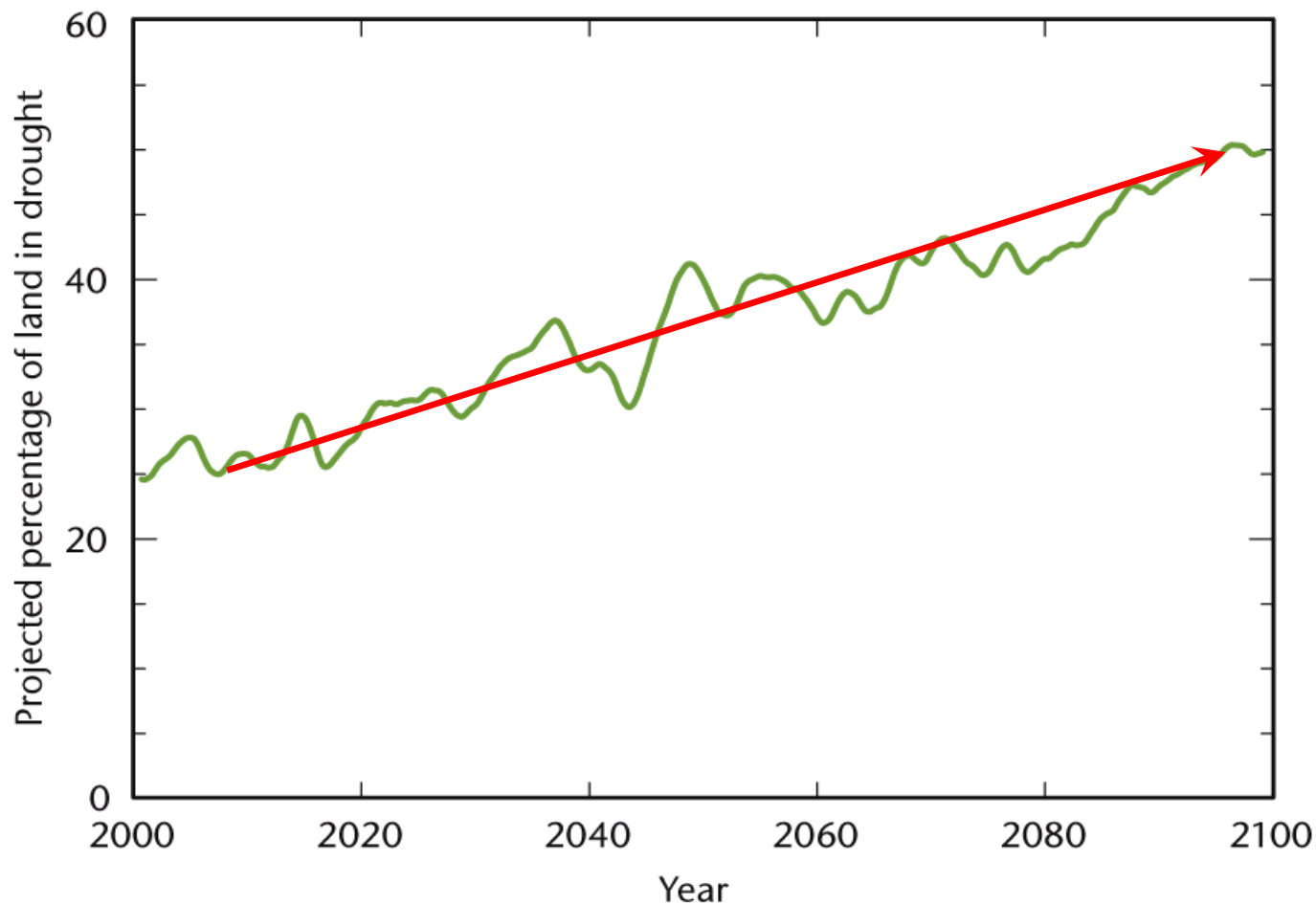
Faculty of Life Sciences

University of Copenhagen

Freshwater shortage – a worldwide challenge

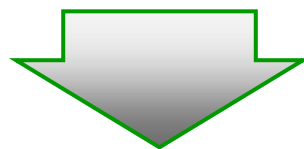


Increase of drought in future climate



Agricultural water use

- ◆ Water for agriculture accounts for 70%—95%
- ◆ 1 kg cereal needs 1—3 tons water
- ◆ 2000—5000 L water produces a person's daily food
- ◆ 70% cereal production come from irrigated land
- ◆ Drought decreases crop yield mostly



More crop per drop



Strategies for sustainable irrigation water use

- To increase WUE of crops
- To use water wisely
- To reduce “unproductive” water losses



How can irrigation water be saved?

- **Micro-irrigation technology (10-25%)**
- **Irrigation scheduling (10-30%)**
- **Deficit irrigation (20-30%)**
- **Reuse of wastewater (10%)**



Traditional irrigation– a waste of fresh water



Flood irrigation



Furrow irrigation

Micro-irrigation techniques – save 10-25%



Microsprinkler

- Surface irrigation
- Subsurface irrigation



Surface drip



Subsurface drip



plastic mulching



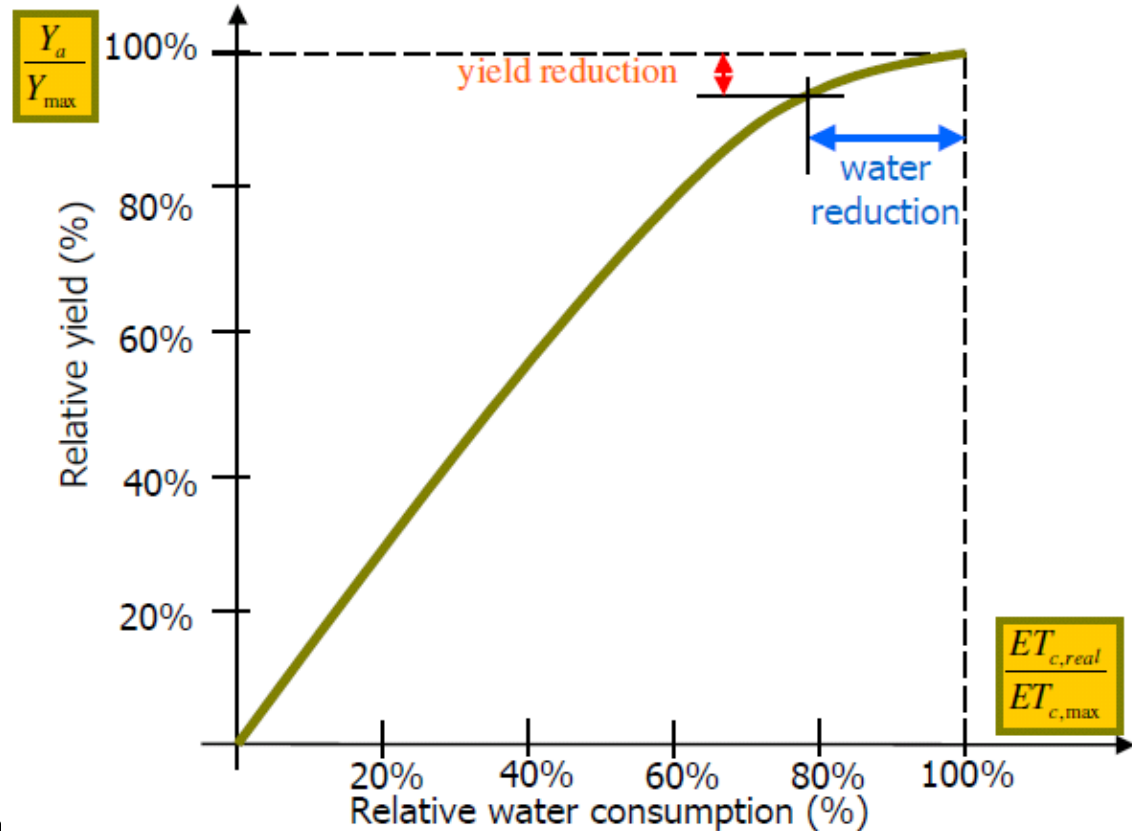
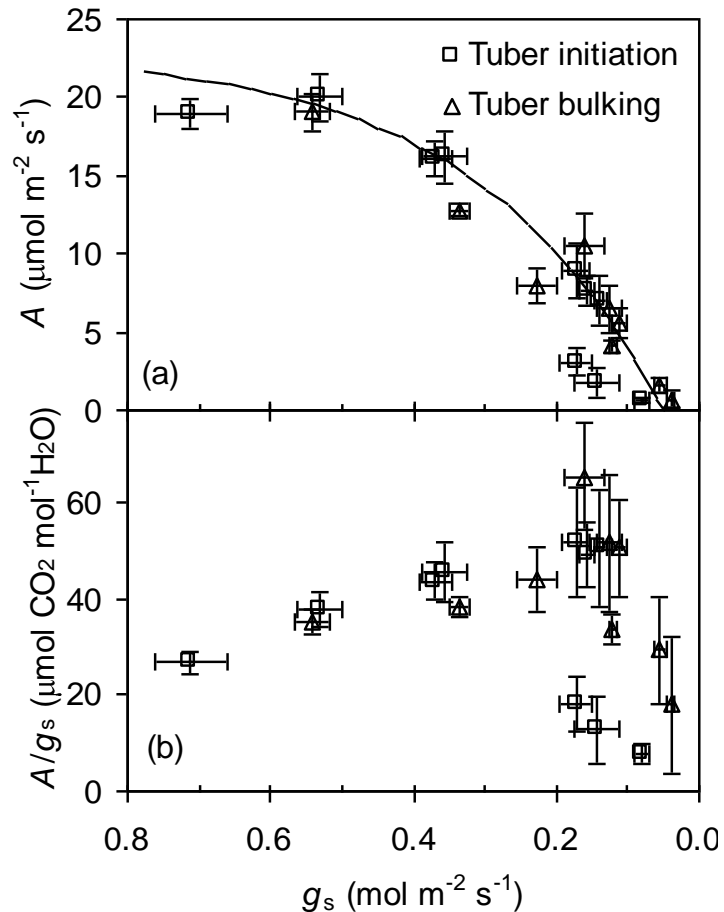
Irrigation scheduling – save 10%

To irrigate the crop at right time and right amount

- Monitor the crop
- Monitor the soil
- Monitor the weather

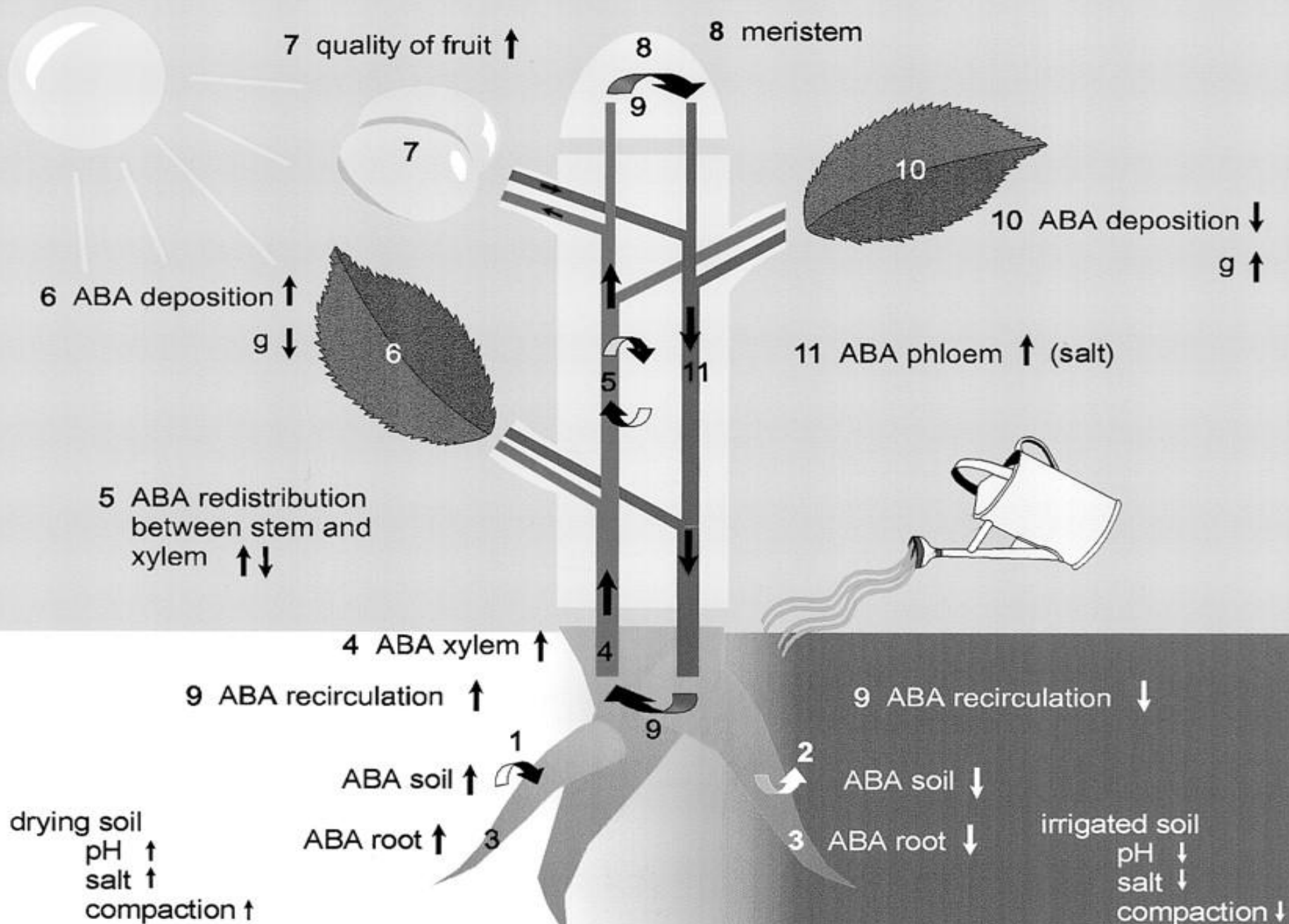


Deficit irrigation strategies



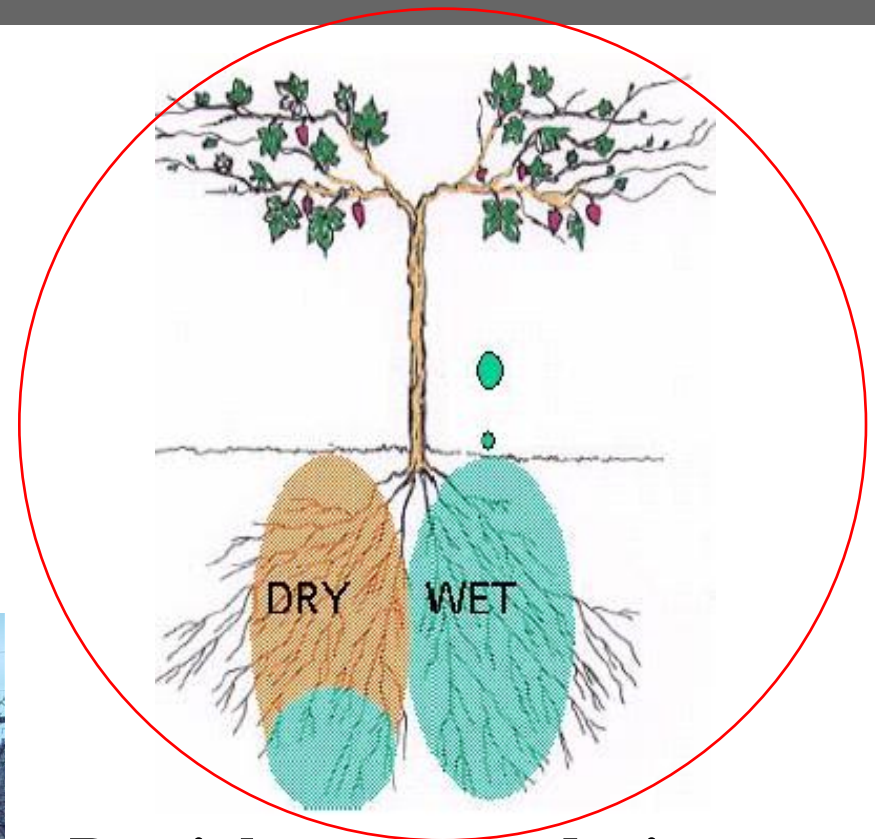
Mild soil drying induced partial stomatal closure reduces crop water use while maintaining photosynthesis and yield





Sauter et al. (2001)

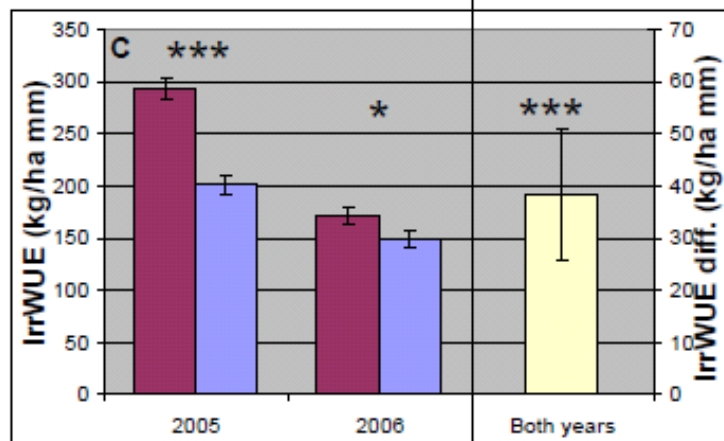
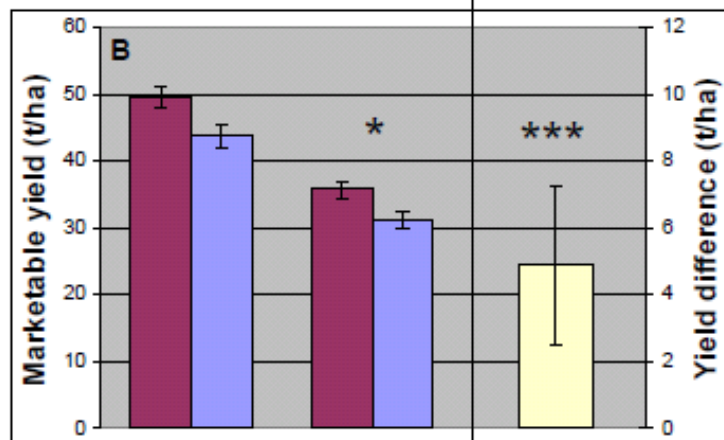
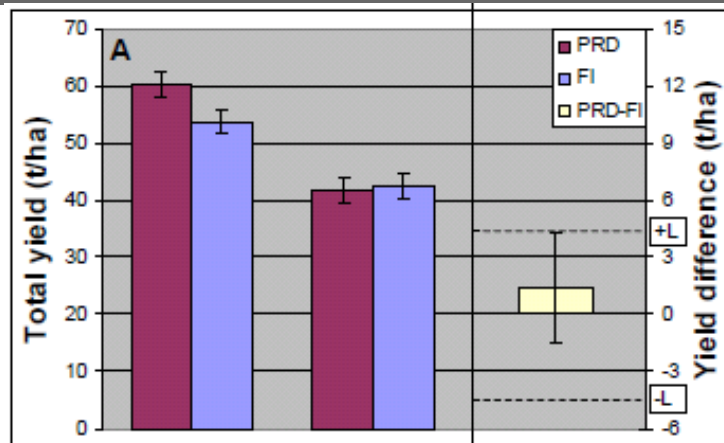
Exploiting chemical Signals (e.g. ABA) moving from the roots by crop management



**Partial root-zone drying
irrigation (PRI) – a
particular form of deficit
irrigation to limit leaf
growth and crop water use**





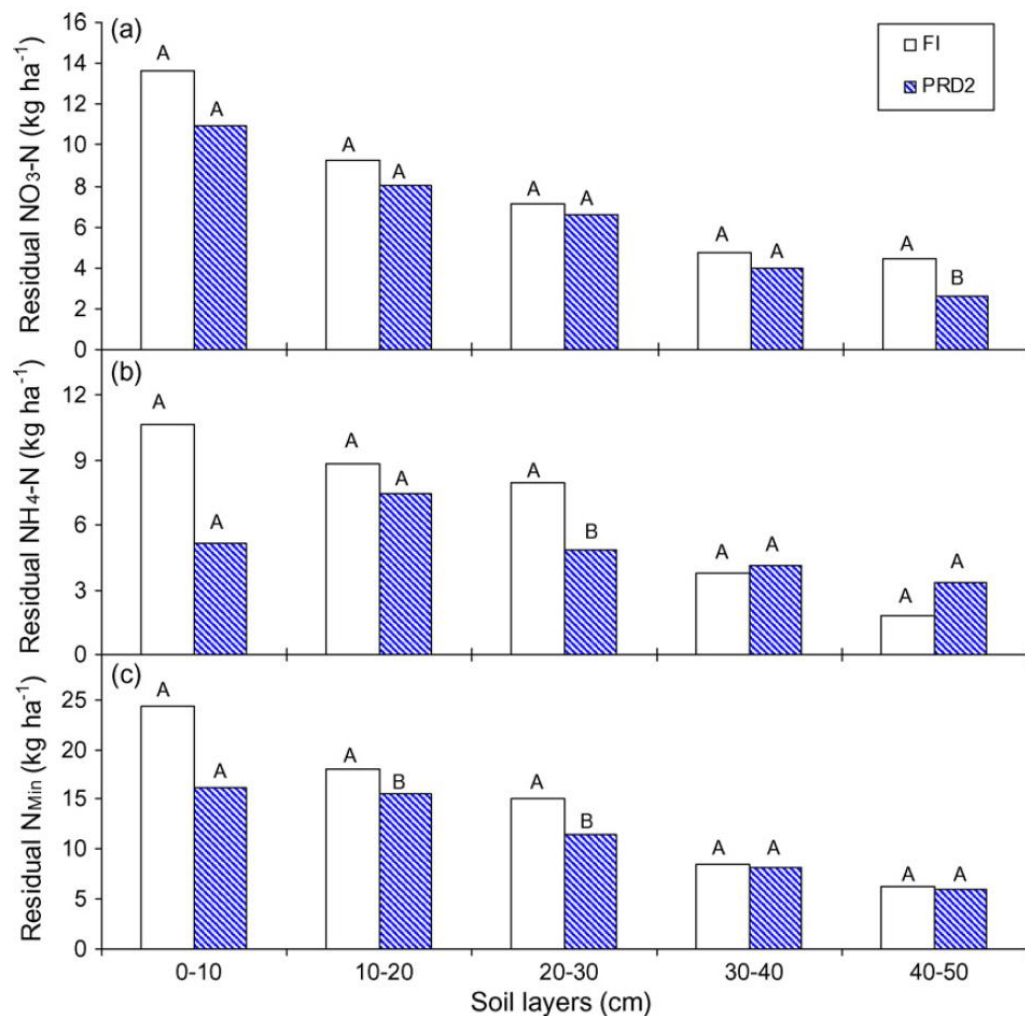


PRI on potato

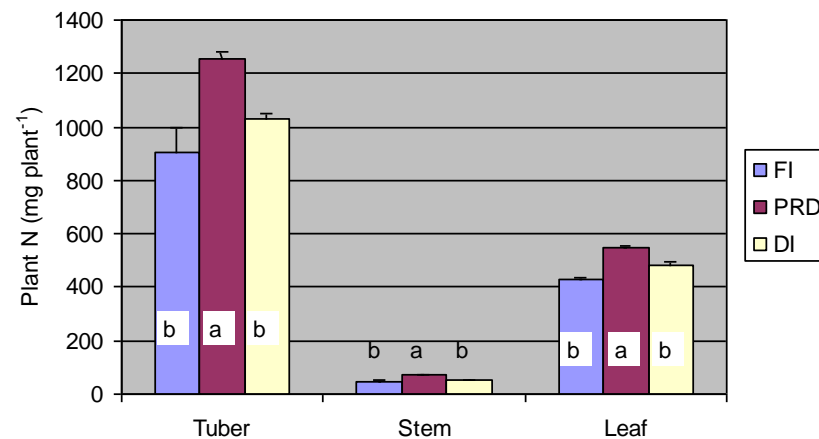


- 30% water saving
- Maintains yield
- Increases WUE
- Increases tuber quality

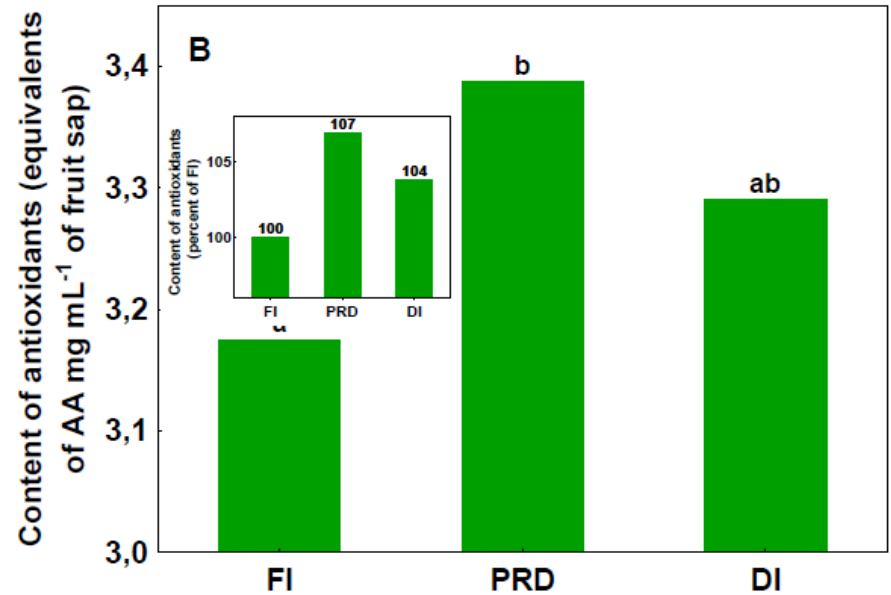
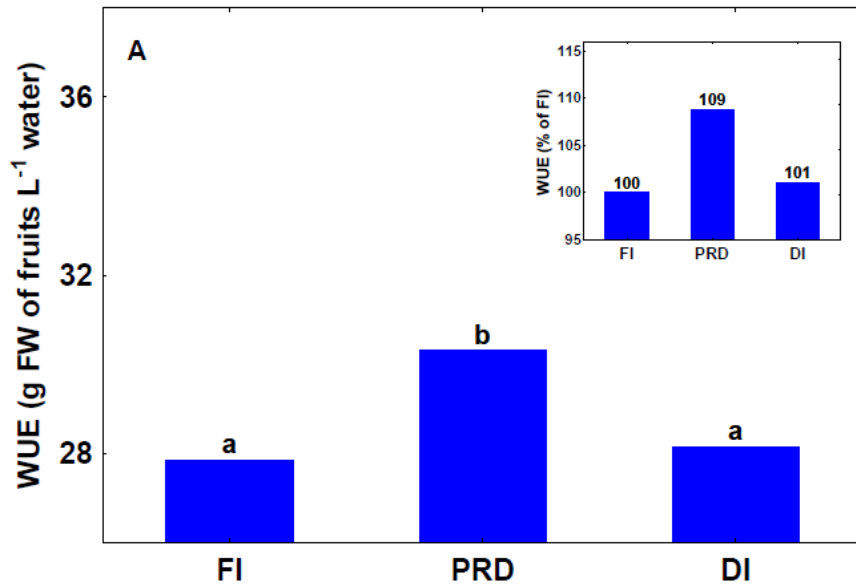
PRI increases N uptake in potato



- Less residue N_{min} in the soil
- High N uptake by plant



PRI on tomato

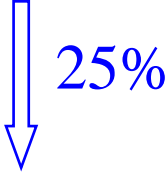
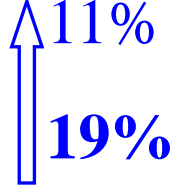


- **38% water saving**
- **Slight yield reduction**
- **Increase WUE**
- **Increase fruit quality**

PRI on tomato

- **25% water saving**
- **18% increases in WUE**

Treatment	Plant water use (l plant ⁻¹)	Increment of dry biomass (g plant ⁻¹)	WUE (g l ⁻¹)
FI	28.17±1.10a	118.34±4.82a	4.20±0.07c
DI	20.66±0.05b	96.20±1.88b	4.66±0.10b
PRI	21.25±0.36b	105.85±1.94b	4.98±0.11a



PRI on tomato

Increases $\delta^{13}\text{C}$

- an indicator for long-term WUE

Treatment	Top leaf	Middle leaf	Lower leaf	Shoot
FI	-26.41±0.31b	-27.52±0.28b	-28.00±0.50b	-27.17±0.23c
DI	-25.60±0.32ab	-26.17±0.24ab	-27.46±0.27ab	-26.13±0.20b
PRI	-24.99±0.18a	-25.77±0.14a	-26.68±0.11a	-25.58±0.03a



PRI on tomato

- Increase N content in top leaves
- Optimized N distribution in the canopy

Treatment	Specific leaf N content (mg cm ⁻²)			Specific leaf ¹⁵ N content (μg cm ⁻²)		
	Top leaf	Middle leaf	Lower leaf	Top leaf	Middle leaf	Lower leaf
FI	0.22±0.01b	0.18±0.01b	0.20±0.02a	10.58±0.41b	8.38±0.71b	9.41±1.02a
DI	0.26±0.02ab	0.23±0.02a	0.22±0.00a	12.44±0.88ab	10.97±0.83a	10.17±0.23a
PRI	0.28±0.02a	0.23±0.01a	0.21±0.00a	13.48±0.79a	11.02±0.73a	9.82±0.14a



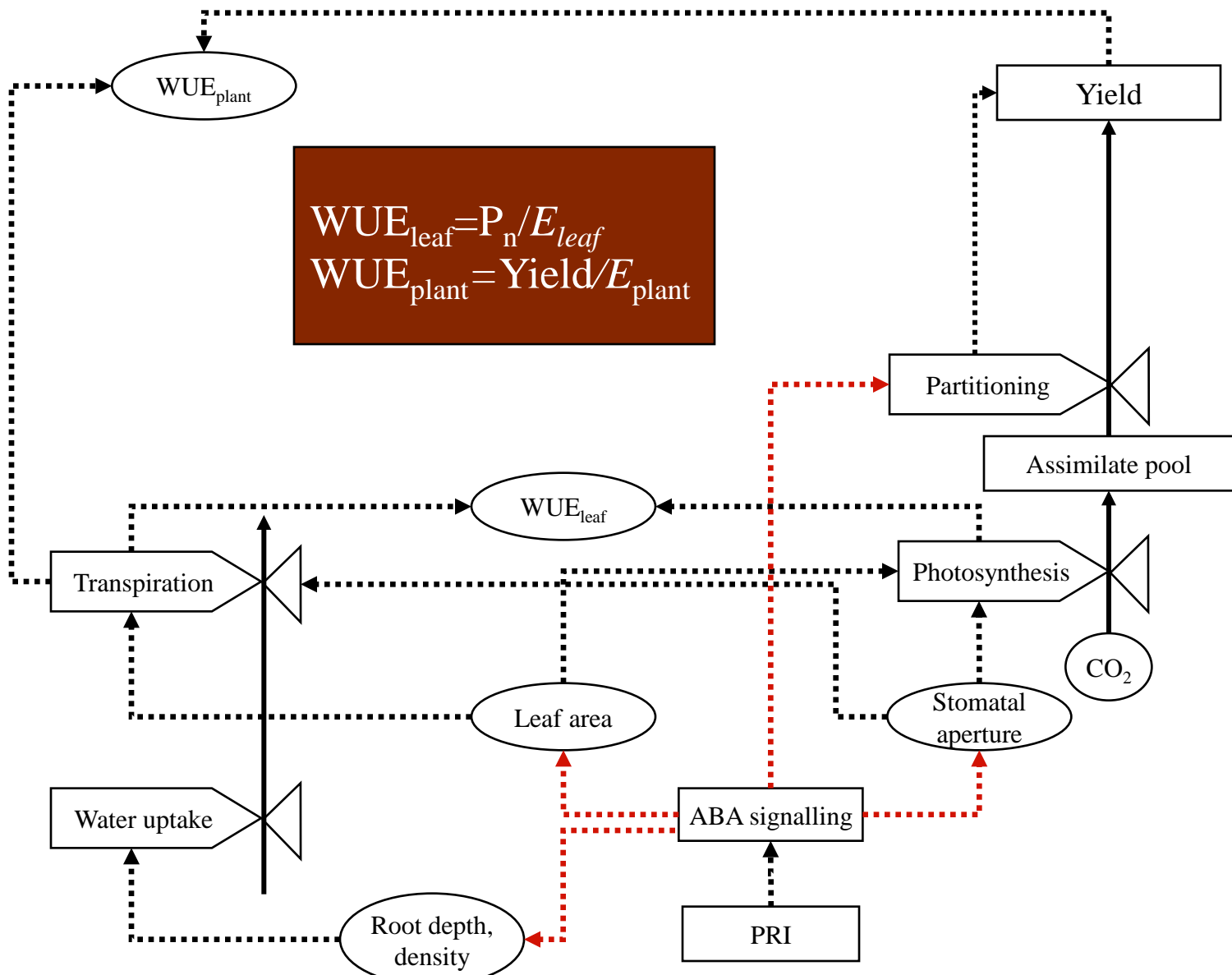
PRI on tomato

- Increases fertilizer N recovery rate

Treatment	¹⁵ N recovery rate (%)			
	Leaves	Stem	Fruit	Total
FI	57.96±2.11a	12.18±1.28b	10.70±0.30a	80.84±1.82a
DI	52.19±0.69b	13.13±0.60ab	9.97±0.74a	75.30±0.71b
PRI	56.27±1.23ab	15.30±0.82a	8.49±1.70a	80.06±2.11ab

↑ 6%





PRI effects on shoot physiology



Benefits of PRI

- **Save irrigation water and increase crop WUE**
- **Improve product quality**
- **Increase soil water storage capacity and reduce surface runoff**
- **Decrease soil evaporation**
- **Stimulate root growth**
- **Enhance crop nutrients (N, K) uptake, reduce risk of nitrate leaching**

An irrigation strategy for the future climate?





Thank You !

Questions, suggestions, please