Quéelles stratégies pour économiser l’eau ?

What strategies for water savings?

Regards croisés européens

Sharin European views

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Irrigation efficiency and optimization
The Optirrig model

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Water savings from improvements of... Irrigation efficiency

As defined in the "cascade scheme" of Serra-Wittling & Molle 2017 [Invited report for the French Ministry of Agriculture]

Color code

Fraction due to Irrigation Water

Fraction due to Rain Water
Water savings from improvements of... Irrigation efficiency

As defined in the "cascade scheme" of Serra-Wittling & Molle 2017 [Invited report for the French Ministry of Agriculture]

Color code

- Fraction due to Irrigation Water
- Fraction due to Rain Water

Rationale

- Calculation of efficiencies and losses in 5 successive stages from irrigation water distribution to crop transpiration
- Complete mixing of rain water (RW) and irrigation water (IW) in soil with time-variable volume fractions carried on through the "cascade scheme"
- Challenge for metrology and modelling: quite tricky to code but physically sound and yields promising results
Water savings from improvements of...
Irrigation efficiency

Stage 1

\[ E = E_d = \frac{A_i}{P_i} \]

Applied \space \space Brought in
Water savings from improvements of irrigation efficiency

Stage 2

\[ E = Ed \cdot Ea = \frac{Si}{Pi} \]

- Leaks from equipments
- Wind drift

Reaches soil → Brought in
Water savings from improvements of...

Irrigation efficiency

Stage 3

\[ E = E_d \cdot E_a \cdot E_s = R_{zi}/P_i \]

\[ \text{Stored in root zone} \quad \text{Brought in} \]
Water savings from improvements of...

Irrigation efficiency

Stage 4

$$E = Ed \cdot Ea \cdot Es \cdot Ec = AETi / Pi$$

Evapotranspirated Brought in
Water savings from improvements of...

Irrigation efficiency

Stage 5

\[ E = Ed.Ea.Es.Ec.Et = Tpi/Pi \]

Finally transpired  Brought in

Rain Water  Irrigation Water

Into the plot (Pi)

Leaks from equipments

Distribution Efficiency \( Ed = Ai/Pi \)

Applied (Ai)

Wind drift

Application Efficiency \( Ea = Si/Ai \)

Reaches soil (Si)

Runoff or drainage

Storage Efficiency \( Es = RZi/Si \)

Root Zone (RZi)

Weeds or excessive storage

Consumption Efficiency \( Ec = AETi/RZi \)

For AET (AETi)

Evaporation

Transpiration Efficiency \( Et = Tpi/AETi \)

For Tp (Tpi)
Stage 5

$$E = Ed \cdot Ea \cdot Es \cdot Ec \cdot Et = \frac{Tpi}{Pi}$$

$$E = [0,1] \times ... \times [0,1] \in [0,1]$$

Examples

$$E = 0.90^5 = 0.69$$  Real-life realistic range

$$E = 0.75^5 = 0.24$$  Quite drastic effect, nope?
Water savings from improvements of...
Irrigation efficiency

Stage 5

\[ E = E_d \cdot E_a \cdot E_s \cdot E_t = \frac{T_{pi}}{P_i} \]

Efficiency \( E = \frac{T_{pi}}{P_i} \) mm/mm or [-]
Productivity \( P = \frac{Y_i}{P_i} \) (ton/ha)/mm
Profitability \( F = \frac{F_i(Y_i)}{P_i} \) (€/ha)/mm

"Then I should definitely increase my irrigation water efficiency"
Water savings from improvements of...

Irrigation efficiency

Stage 5

Efficiency E = Tpi/Pi  mm/mm or [-]
Productivity P = Yi/Pi  (ton/ha)/mm
Profitability F = Fi(Yi)/Pi  (€/ha)/mm

"Then I should definitely increase my irrigation water efficiency"

"Yes buddy and you should really start by reducing the losses"
Water savings from improvements of... Irrigation efficiency

**Technical losses**
- Various upstream losses
- Improper, defective or miscontrolled plot equipment

**Tactical losses**
- Dummy, default or too constrained irrigation strategy

"Then I should definitely increase my irrigation water efficiency"

"Yes buddy and you should really start by reducing the losses"
Water savings from improvements of... Irrigation efficiency

**Optirrig**

Generation, analysis & optimization of crop irrigation scenarios
Dedicated module that handles irrigation water efficiency

**Tactical improvements vs. Tactical losses**
Improving irrigation strategy by tuning irrigation scenarios

"Then I should definitely increase my irrigation water efficiency"
"Yes buddy and you should really start by reducing the losses"
Water savings from improvements of...

Irrigation efficiency

"Ahem these irrigations took place just before rain events"
Water savings from improvements of...

Irrigation efficiency

Cumulative deep drainage from sowing to harvest (mm)

"Ok there was drainage of irrigation water here"
Water savings from improvements of... Irrigation efficiency

Efficiency module
Output example 3

Cumulative soil evaporation from sowing to harvest (mm)

"Some of it is evaporated, some of it expectedly transpirated, huh?"
Water savings from improvements of...

Irrigation efficiency

Efficiency module
Output example 4

"Seems good as more transpiration than evaporation occurs AND the pale blue fraction increases with time "

Cumulative crop transpiration from sowing to harvest (mm)

- Transpiration of irrigation water (mm)
- Transpiration of rain water (mm)
- Irrigation (mm)
- Rain (mm)
Water savings from improvements of...

Irrigation efficiency

Summary of the key terms in the efficiency cascade scheme

"Ouch my upstream losses hurt and irrigation storage is so damn high!"
Irrigation efficiency

"I need to evaluate or reformulate my irrigation strategies, especially in a context of limited resource availability"

"Optirrig is here for you, and can be tuned to save water by improving irrigation efficiency... but instead of an autograph I made a little drawing for you"
"Think about it:

1- Maximum crop yield is obtained for higher irrigation amounts than those of maximum irrigation efficiency

2- Reducing irrigation to improve efficiency is a virtuous behavior that may need/deserve a financial reward"