How water productivity knowledge can inform project design and strategic planning

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Tunis
ICARDA is a decentralized R4D international institute for agri-food systems in non-tropical drylands.

Partnership with NARS
Family Farming

Staff: 350
Scientists: 70

icarda.org
1. Water Productivity (WP): a multiscale framework of Indicators

$$ WP = \frac{\text{Return}}{\text{Unit of Water Consumed}} $$

**What return?**
- Biomass, grain, fruit, meat, milk, fish (kg)
- Income ($)
- Social benefits (employment)
- Nutrition (energy, protein, micro-nutrients, vitamins...)
- Environmental benefits (C sequestration, C, Land Degradation neutrality...)

**What water?**
- Quality (salinity, waste water)
- Renewability
- Seasonality

**Used (vs. depleted)**
- Evapotranspiration
- Percolation
- Quality deterioration

**Data Quality?**
- Measurement (ET, soil measurement)
- Modeling
- Remote Sensing

Can be used at any scale from field, farm to landscape to country
May be worth to decompose a bit more the equation

\[ WP = \frac{\text{Grain Production}}{\text{Unit of Water Consumed}} \]

or

\[ WP = \frac{\text{Grain Production}}{\text{Evaporation+Tranpiration}} \]

- Bread Wheat
- Barley
- Winter or Spring Chickpea
The same framework for different agro-ecosystems

Irrigated: 17 % More job per drop
Rainfed: 22 % More food per drop
Agro-pastoral: 58 % LDN and Livelihood
Desert farming: 3 % Socio-ecological Resilience

NENA Agricultural Land (2.5 M km²)
Untapped potential of Water Productivity Gains in farmers fields

Raised Bed + Improved Wheat

WP Food gain = 1.3/0.75 = 1.7

### Economic Wp $/m3

<table>
<thead>
<tr>
<th>Crop</th>
<th>Farmer N</th>
<th>Farmer Irrigation</th>
<th>Farmer Yield</th>
<th>Farmer WP</th>
<th>Recomm ended N</th>
<th>Recomm ended Irrigation</th>
<th>WP</th>
<th>% WP increase</th>
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</thead>
<tbody>
<tr>
<td>Cluster bean</td>
<td>20</td>
<td>200</td>
<td>1700</td>
<td>0.47</td>
<td>60</td>
<td>100</td>
<td>1.27</td>
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<tr>
<td>Mustard</td>
<td>60</td>
<td>350</td>
<td>1800</td>
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<td>250</td>
<td>1.03</td>
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<tr>
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<td>550</td>
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<td>160</td>
<td>400</td>
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**Poor management**

**Improved management**
A question to ask systematically

Is water the major limiting factor of land productivity?

1. Eg. Mineral Nutrition, pests and diseases, weeds.
2. Irrigation Management
3. Improved variety, Rotation, Association

Durum wheat in farmers fields in Tunisia
(adapted from Ben Zekri, 2017 – These SupAgro)
Strong increase of WP can be obtained with Best Agronomic Practices

Rajasthan (India)

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<th>Farmer Yield</th>
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Increased N fertilisation
Explore Trade-Offs between the various dimensions of Water Productivity

Solution may be scale-dependent (farm vs landscape vs country)

Keep always an eye on the Amount of water used
2. A framework to develop projects based on water productivity

SHARE Knowledge, Technologies and Data

COMBINE Technologies in Systemic Innovation

ACCELERATE co-design with Farmers Communities

ENABLE Policies and Institutions for Systemic Innovation

INTEGRATE Innovations and Methods

<table>
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<tr>
<th>Agro-ecosystems</th>
<th>Area (m ha)</th>
<th>%</th>
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<tbody>
<tr>
<td>Irrigated systems</td>
<td>312</td>
<td>15</td>
</tr>
<tr>
<td>Rainfed systems</td>
<td>512</td>
<td>25</td>
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<tr>
<td>Agropastoral systems</td>
<td>873</td>
<td>43</td>
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<tr>
<td>Desert farming Potential</td>
<td>342</td>
<td>17</td>
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</table>
Don’t re-invent the wheel…but check data quality

Share Knowledge and Technologies

\[ WP = \frac{\text{Return}}{\text{Unit of Water Consumed}} \]

Net Houses
- Has the same net benefit as cooled greenhouse, thanks to savings in water and electricity (for cooling)
  - icarda.org

Solar Cooling
- Enhancing the current cooling system using solar energy saves up to 60% water

Hydroponics
- Increases Yield and Water Productivity by 50%

Smallholders in Yemen

Arabian Penninsula Program (Donors: AFESD, IFAD, OFID)
Assess Combinations of Technologies in a nexus

Eg. Intercropping drip irrigation fruit trees with rainfed cereal-legume rotations and with real-time ET estimate

FIELD EXPERIMENTS

DATABASES

REMOTE SENSING

MODELS
(Crops, Farm, Landscape)

SUITABILITY MAPPING

Ex ante Trade-offs analysis of different WP at different scales
Increase System’s Water Productivity in a socio-economic context

Co-design systemic solutions with local communities

- Select the most suitable combinations of technologies for soil and climate
- Adapt to the local community aspirations
- Adapt to farm and watershed context
- Adapt to the project duration and funding
- Re-assess the systemic innovation in the Water Productivity Framework (ex ante)
- On-farm and On-landscape experiments (co-design)
- Lessons learnt go back to the SHARE module (co-learn)
"The analysis shows that achieving high AWP in all the region would either increase crop production by 8 million tons or save 8.1 BCM of water annually maintaining current production levels"
• **The multidimensional** nature of Water Productivity
• **Quality of data** → more measurements of WP across the range of drylands agro-ecosystems
• **Explore trade-offs and synergies** (among WPs and with Water Use)
• **At different** scales (field, farm, watershed, country)
• **An Integrated Framework** to support water productivity based transformation of Agriculture (DryArc)