Best management practices for efficient use of water and for preventing contamination from plant nutrients and pesticides

Aldo Ferrero, Dario Sacco
Water Balance and water excess

- irrigation
- evaporation, transpiration
- rainfall
- runoff
- leaching
- internal fluxes
- crop water uptake
- variation in SWC
- drainage
1. Increasing in water use efficiency
2. Reducing water runoff
3. Preventing environmental contamination by plant nutrients and plant protection products
Increasing in water use efficiency
Water use in Po valley agriculture

<table>
<thead>
<tr>
<th>Millions m$^3$</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.02 - 25</td>
<td>Little water use</td>
</tr>
<tr>
<td>25 - 50</td>
<td>Moderate water use</td>
</tr>
<tr>
<td>50 - 100</td>
<td>Significant water use</td>
</tr>
<tr>
<td>100 - 200</td>
<td>Very significant water use</td>
</tr>
<tr>
<td>200 - 400</td>
<td>Very high water use</td>
</tr>
<tr>
<td>400 - 700</td>
<td>Extremely high water use</td>
</tr>
<tr>
<td>&gt; 700</td>
<td>Extremely high water use</td>
</tr>
</tbody>
</table>

Rice

Maize and grassland

ISTAT, 2010
6th Censusino Generale dell'Agricoltura
## Irrigation effect and water use efficiency

<table>
<thead>
<tr>
<th>Crop</th>
<th>Volume (mm)</th>
<th>Irrigated Yield (t ha⁻¹)</th>
<th>Rainfeed Yield (t ha⁻¹)</th>
<th>Yield Reduction (%)</th>
<th>Water Use Efficiency (kg m⁻³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>187</td>
<td>11.8</td>
<td>8.7</td>
<td>26</td>
<td>1.70</td>
</tr>
<tr>
<td>Sorghum</td>
<td>300</td>
<td>8.8</td>
<td>8.3</td>
<td>20</td>
<td>0.70</td>
</tr>
<tr>
<td>Sunflower</td>
<td>200</td>
<td>3.5</td>
<td>2.7</td>
<td>23</td>
<td>0.40</td>
</tr>
<tr>
<td>Grassland</td>
<td>344</td>
<td>12</td>
<td>8</td>
<td>35</td>
<td>1.25</td>
</tr>
<tr>
<td>Leys</td>
<td>326</td>
<td>15</td>
<td>13</td>
<td>14</td>
<td>0.64</td>
</tr>
<tr>
<td>Lucerne</td>
<td>326</td>
<td>15</td>
<td>12</td>
<td>15</td>
<td>0.67</td>
</tr>
</tbody>
</table>

Irrigation methods in Po Valley

- Sprinkler
- Drip
- Surface
- Flooding
Comparison between water use efficiency

Humphreys et al., 2005, Grignani et al., 2009

Berruto et al., 2009
Innovation in irrigation system

Soil and crop mapping, sensors, models and precision irrigation

*Picture from NETSENSE S.R.L.*

Morari et al., 2015

Site specific irrigation
Reducing water runoff
Mitigation measures: soil tillage

Reduce tillage intensity

Direct and indirect action to limit runoff
- Increase crop residues on the surface
- Reduce machinery transit and avoid ploughing pan

Sod seeding

Ploughing
Mitigation measures: cover crops

Establish plant annual cover crops to avoid bare soil

- Fast and dense establishment of vegetation
- Abundant crop residues on the field after crop termination

Oilseed rape
Maize after Phacelia
Mitigation measures: vegetative buffers

Establish or maintain in-field buffer

Slow down surface runoff and provide infiltration areas for runoff water

• Perpendicular to the runoff water flows and be part of natural vegetation (non-invasive species)
• Provide a dense vegetation cover at the downslope end of field
Dashboards and indicators

- Dashboards helps to make stepwise decisions highlighting important factors
- Decision based on major factors influencing runoff risk

**Proximity to surface water** (adjacent/not adjacent)

**Topsoil permeability** (low/medium/high)

**Steepness of slope** (steep/moderate/shallow)

**Risk level**
- VERY LOW
- LOW
- MEDIUM
- HIGH
Preventing environmental contamination by plant nutrients and plant protection products
Fertigation: Increase in nutrient use efficiency

- Synchronization of nutrient supply with crop demand
- Reduction in fertilizers application due to higher nutrient efficiency
- Reduction in nutrient leaching
- Less soil compaction due to reduced machinery transit
Drip irrigation in rice

Potential increase in crop productivity

*Reduce water consumption (50-70% water saving)*

*Reduce nutrients and pesticides losses*

Limited uptake of hazardous metals

Extend rice cultivation in areas with soil, water and land limitations

Ongoing project in collaboration with Netafim

**Pesticides pollution in ground waters**

*(ISPRA, 2010)*

**Average water consumption over the season**

![Map of rice district with water consumption data](image)

- **In red:** > 0.10 µg/L

*Monaco and Sali, 2014, modified*
Alternative irrigation on rice: GHG emissions

Yearly cumulative emissions
(Mg CO₂-eq ha⁻¹ yr⁻¹)

Flooding
Delayed Flooding
Turned irrigation

CH₄
N₂O

Bertora et al., 2015
Most relevant publications


Zavattaro, L., Monaco, S., Sacco, D., Grignani, C., 2012. Options to reduce N loss from maize in intensive cropping systems in Northern Italy. *Agriculture, Ecosystems & Environment* 147, 24–35.
