Enhancing food security with increased water scarcity

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A region with multiple stresses

- Physical water scarcity
- Rapid NR degradation and desertification
- Groundwater depletion
- Drought
- Salinity
- Climate change

Decrease of the Souss aquifer level in Morocco
Region with multiple stresses

- Many countries with chronic water scarcity
- Water for agriculture in dry areas is declining
- Rapid NR degradation and desertification
- Climate change adds to the problems
- Energy competes
- Consequences

Agricultural water

- Agriculture uses most of the water
- Agricultural water is declining
- Mostly used with low productivity
New water … limited !!!!

- Surface, mostly tapped
- Ground, over exploited
- Marginal-quality, small amounts, environment, health
- Desalination, costly, environment, transport
- Water transfer, cost and politics

Conventional coping strategies: insufficient !!!

1. Increasing crop yield (land productivity)

Great !! but needs more water

Which is not available
2. Demand management/ pricing water

- Not working in this region
  - Politically and socially infeasible
  - Weak Institutions
- Innovative alternatives are needed

3. Increasing efficiency

\[
\text{Efficiency} = \frac{\text{Output}}{\text{Input}} \times 100\%
\]

- < 100% Implies losses during the process
- Applies to water, energy and food processes
- Attracts most of the attention
Irrigation efficiency: “real” vs “paper” saving/losses

Issues of irrigation efficiency

- Reflects the performance of the irrigation system (engineering aspects)
- Ignores recoverable losses!! energy requirements!
- Nothing to do with the return to water or energy (productivity)
- Wrongly used to judge the whole farm water management system
- Necessary to improve but will add a little more water at larger scale
4. Modernizing irrigation systems: The fallacy

- Meant for higher efficiency: not guaranteed
- Savings are not totally due to efficiency improvement

One can under irrigate
No DP / 100% application Eff
50% storage Eff.

One can over irrigate
100% storage efficiency
50% application efficiency

• Under irrigation
  – Application eff. 100%
  – Storage eff. 50%

• Over irrigation
  – Application eff. 50%
  – Storage eff. 100%
Modernizing irrigation: water savings!

- Does irrigation modernization save water? Yes
- Does increasing Irrigation Efficiency from 50% to 80% save 30% water? No
- Higher productivity is mainly associated with:
  - Provide better soil water due to frequent irrigation
  - Fertigation more frequent and uniform
  - Better weed control
- At cost: Investment, Maintenance, Skill
- Modernizing surface irrigation; ignored option

This is not to say that conventional approaches are not necessary... they help but can not overcome increasing agricultural water shortages in this region

A paradigm change is needed
From "efficiency" to "productivity"
Water productivity: the concept

\[ WP = \frac{\text{Return}}{\text{Unit of water consumed}} \]

**What return??**
- Biomass, grain, meat, milk (kg)
- Income ($)
- Environmental benefits (C)
- Social benefits (employment)
- Energy (Cal)
- Nutrition (protein, carbohydrates, fat)

**What water??**
- Quality (EC)
- Location (GW depth)
- Time available

**Consumed (depleted)**
- Evaporation
- Transpiration
- Quality deterioration

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### Potential water productivity improvement

#### Nutritional WP Calories/m3

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#### Nutritional WP Protein gr/m3

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#### Nutritional WP Calories/m3

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24/03/2015
It takes a litre of water to produce every calorie

Scales and drivers to increase WP

- **At the basin level:**
  - competition among uses (Env., Ag., Dom.)
  - conflicts between countries
  - Equity issues

- **At the national level:**
  - food security
  - hard currency
  - sociopolitics

- **At the farm level:**
  - maximizing economic return
  - Nutrition in subsistence farming

- **At the field level:**
  - maximizing biological output
Potential WP improvements

- Reducing evaporation
- Improving management
- Enhancing genetic resources
- Great potential in developing countries

Potential practices

- Supplemental irrigation
- Deficit irrigation
- Germplasm
- Cultural practices
- Water harvesting
Tradeoffs between water & land productivity

$$y = -0.4278x^2 + 4.7328x - 0.543$$
$$R^2 = 0.7611$$

Strategic changes to reduce the impact of water shortage on agriculture

- Cropping patterns: change to be more water productive
- NRM Focus: from land to water
- Indicators: from efficiency to productivity
- Scale: from local to regional
- Policies: from reactive to proactive to foster change
It is a prime time for change !!!!

Thank you