

Integrated Production Systems for **Nutrition and Employment** In **smallholders** agriculture of the **Dry Regions**.

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*Protected Production of Fruits and Vegetables for Nutrition Security in
Urban and Peri-Urban Environments*

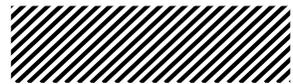
Outline



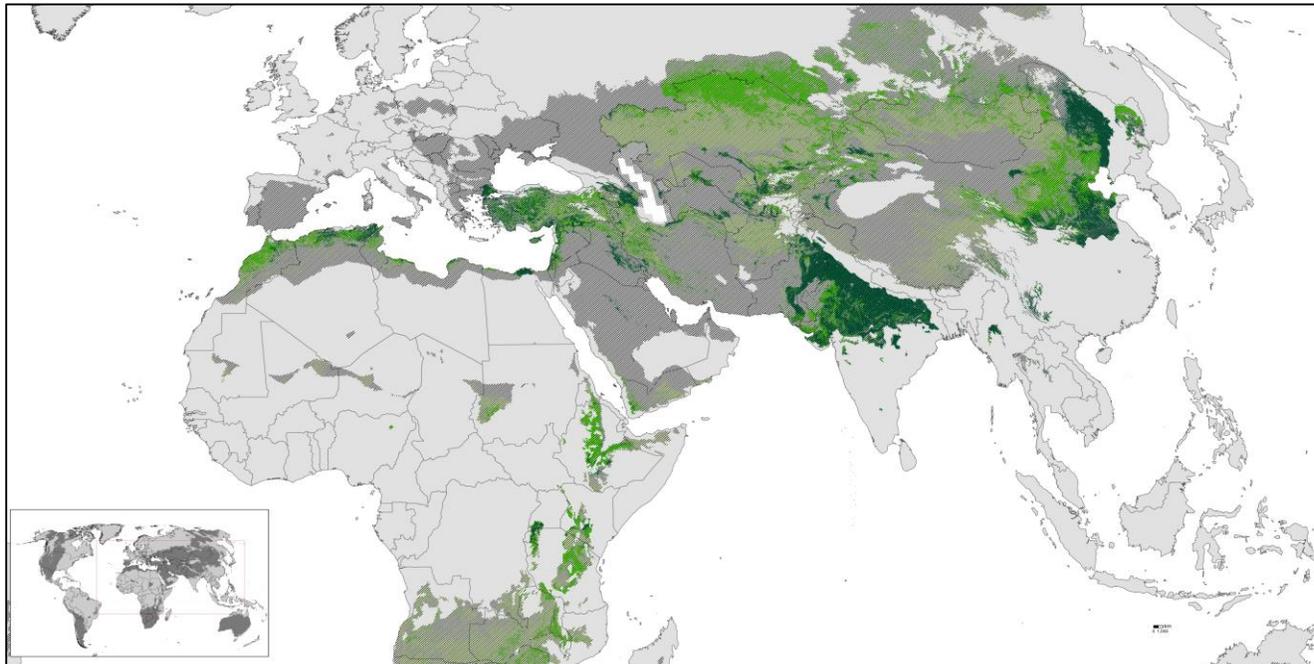
1. Challenges for Agriculture in Dry Regions
2. Protected Agriculture in Arabian Peninsula
3. Way Forward

1. Challenges for Agriculture in Dry Regions

Dry Areas



Non-tropical dry areas



- Increasingly drier and hotter
- Food and nutrition insecurity
- Unemployment
- Fragile states
- Irrigation water is key

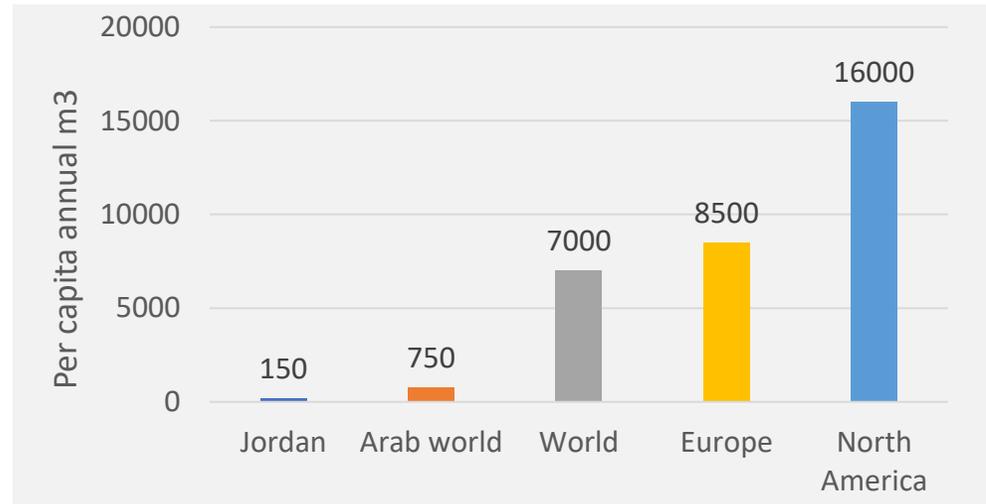
Agricultural Production Systems

-  Irrigated Systems
-  Rainfed Systems
-  Pastoral Systems

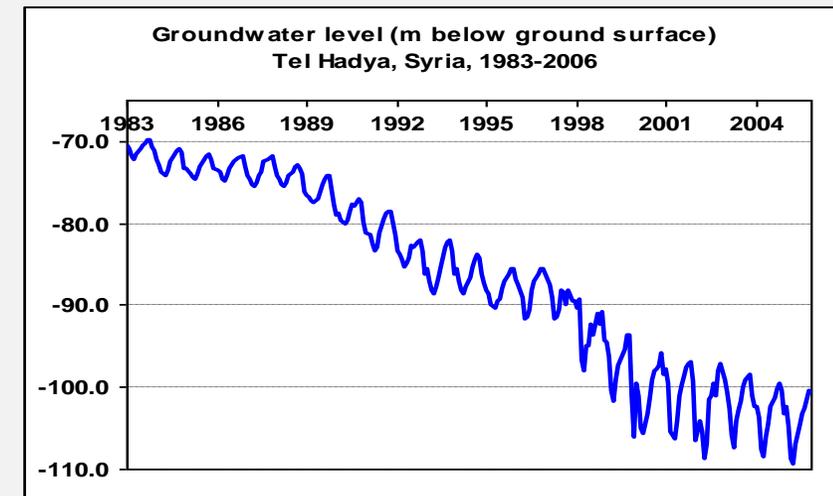


Efficient Use of Irrigation Water is Key for the Region

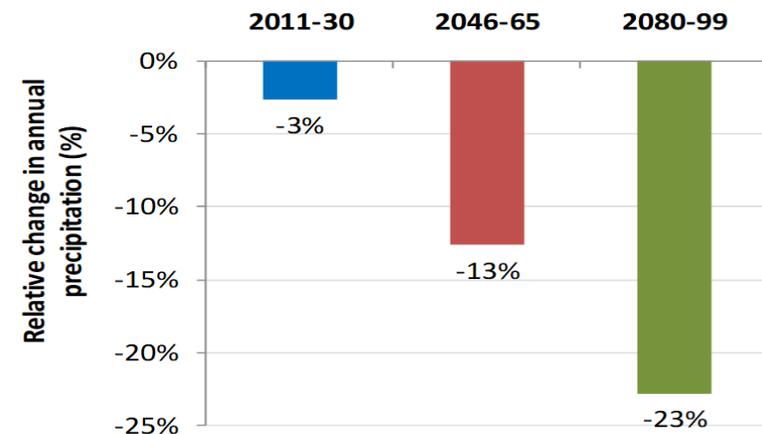
Many countries have chronic water scarcity problem



Water resources need to be protected

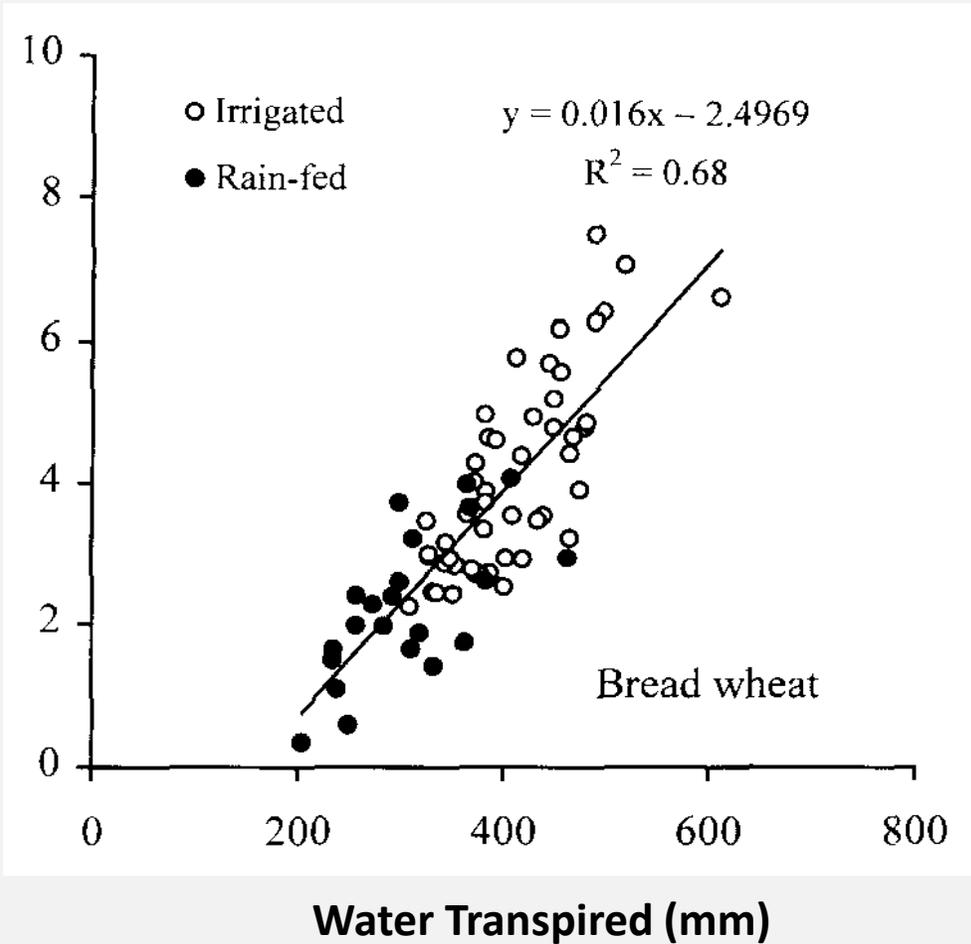


Climate change adds to the problem



More Yield, More Water Transpired

Wheat yield (t/ha)



More
transpiration
less evaporation
or
less percolation?



Think Water Productivity (WP)

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

What return?

- Biomass, grain, fruit, meat, milk, fish (kg)
- **Income** (\$)
- **Social benefits** (employment)
- **Nutrition** (call., protein, carbohydrates, fat)
- **Environmental** benefits (C)

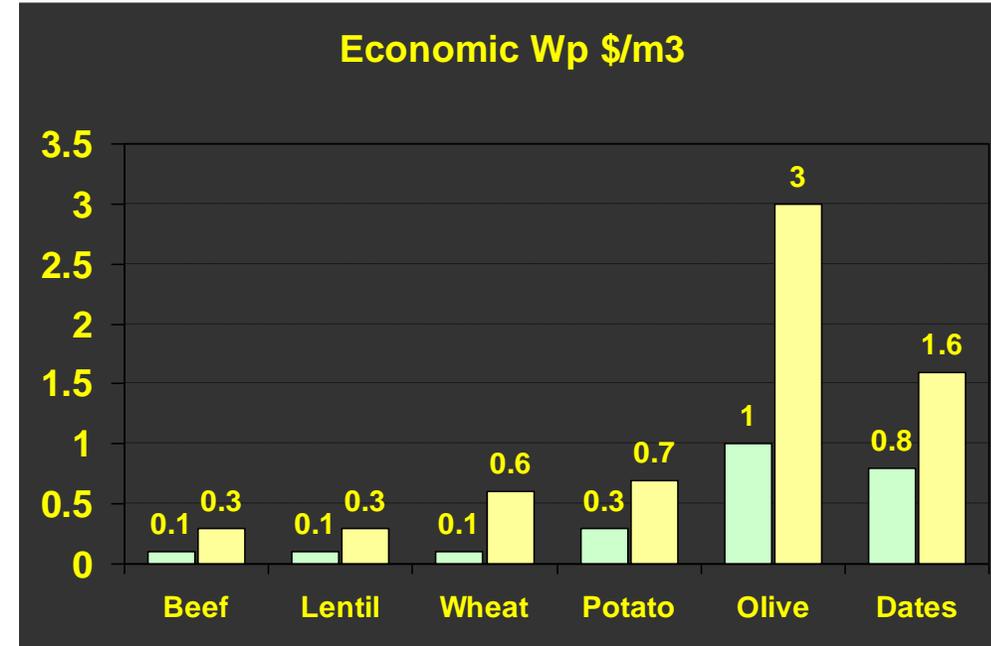
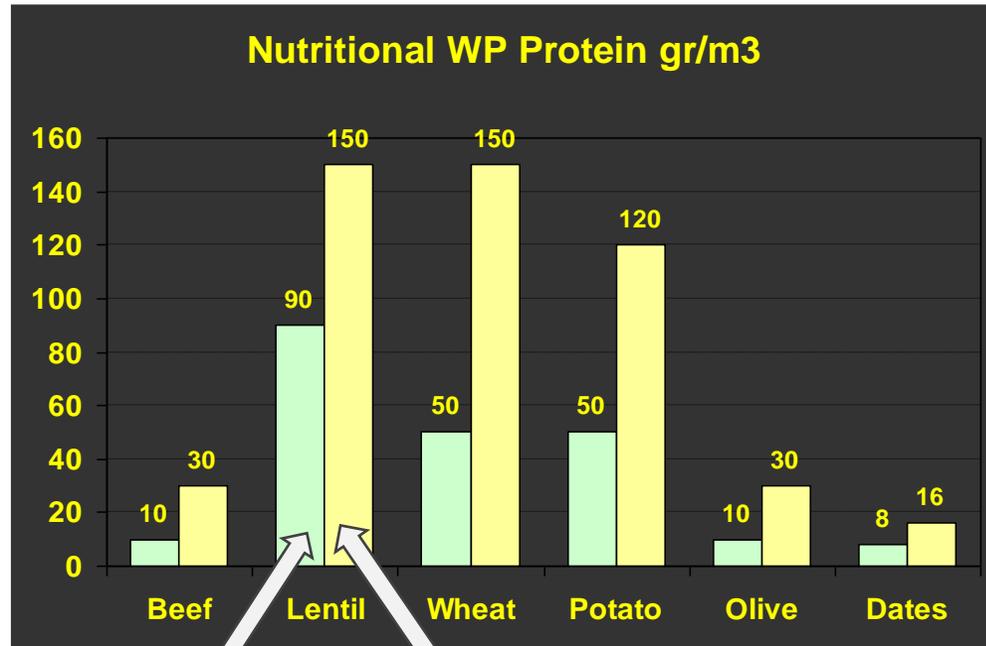
What water?

- Quality (EC)
- Location (GW depth)
- Time available

Consumed (depleted)

- Evaporation
- Transpiration
- Quality deterioration

Explore the Trade-Offs in Water Productivity



Poor management

Improved management

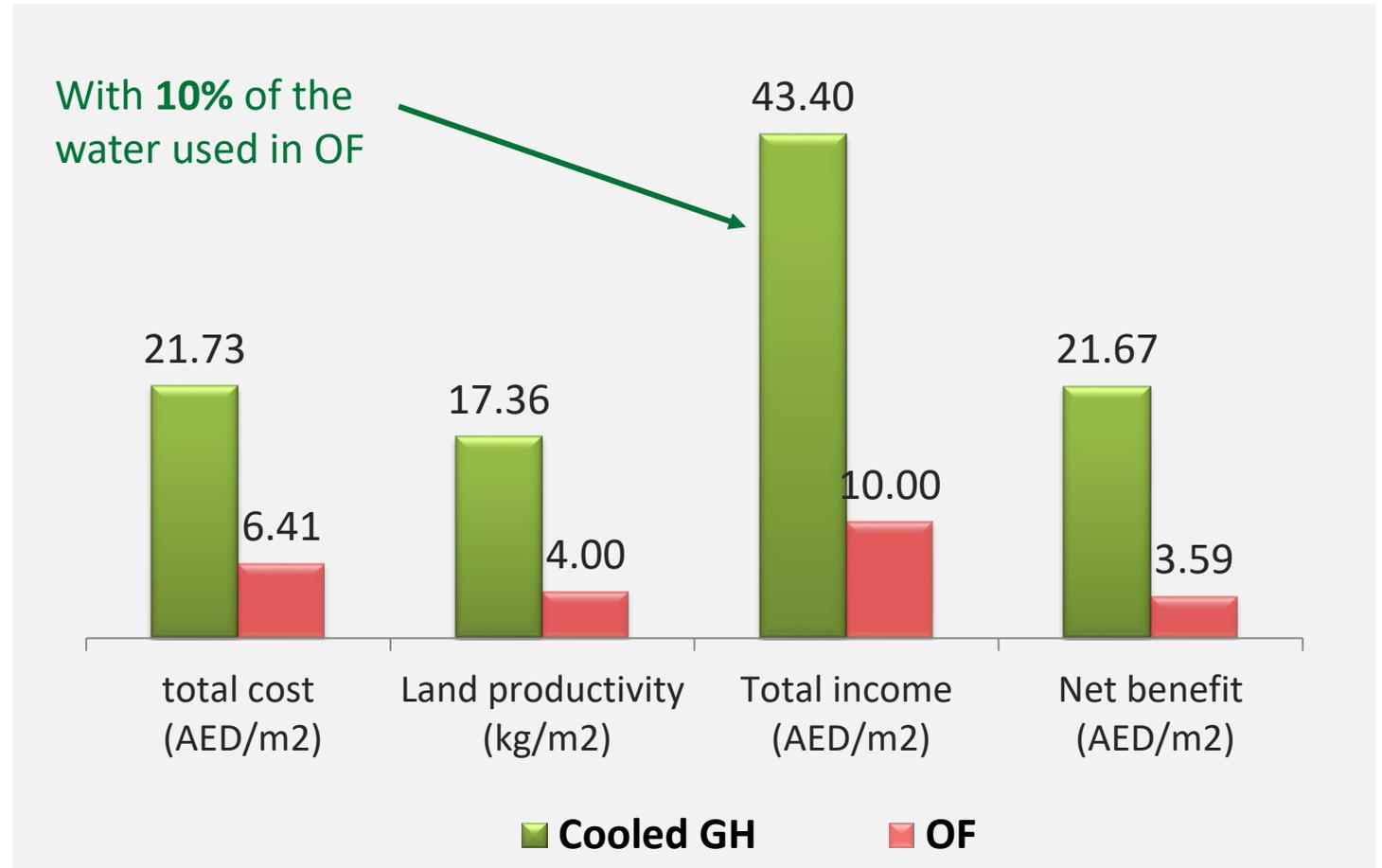
Keep the precious irrigation water in the dry areas for fruits and vegetables?

Protected Agriculture Strongly Improves Land and Water Productivity



UAE uses **20 million m³** of water to produce **112,000 tons** of Tomatoes.

Photo: Peter Essick



2. Protected Agriculture in Arabian Peninsula

Achievements

Component-Based Research

- Development/improvement of a technology with components of the cropping/farming system (water, soil, plant, disease, etc.)
- Can be done in big farms in high-tech greenhouses

System-Based Research

- Innovation is in the interactions among components
- Conducted with smallholder farmers and low-cost plastic houses
- Has component of scaling out/scaling up

Capacity Building

Donors: AFESD, IFAD, OFID



2.1. Technological Developments



Donors: AFESD, IFAD, OFID



Introduced “Net House” to the Region

Results

- Better ventilation
- 8-9 months of year
- High yields
- Same net benefit as cooled greenhouse
 - ← savings in water and electricity (for cooling)

Donors: AFESD, IFAD

Enhanced Cooling System, Using Solar Energy

with American University of Ras Al Khaimah (UAE)



Cooling uses 2-10 times more water than irrigation

Improved cooling system using solar energy saves up to 60% water



Donors: AFESD, IFAD

Adoption of Soilless-Production System

Increases Yield and Water Productivity by 50%



Donors: AFESD, IFAD, OFID

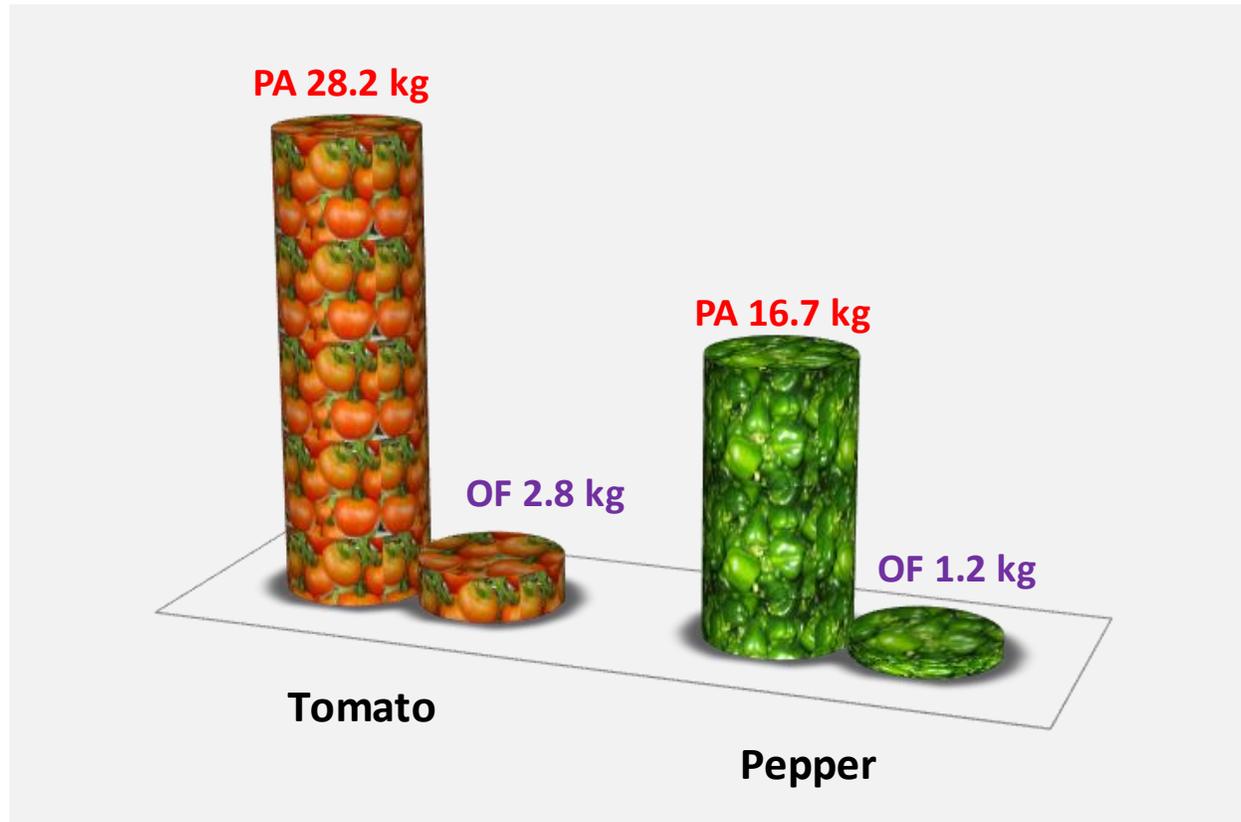


Before

After

Genotypic Studies

Species and Varieties



Average Productivity of 1 m³ of water in Protected Agriculture (PA) Vs. Open Field (OF)



Integrated Pest Management



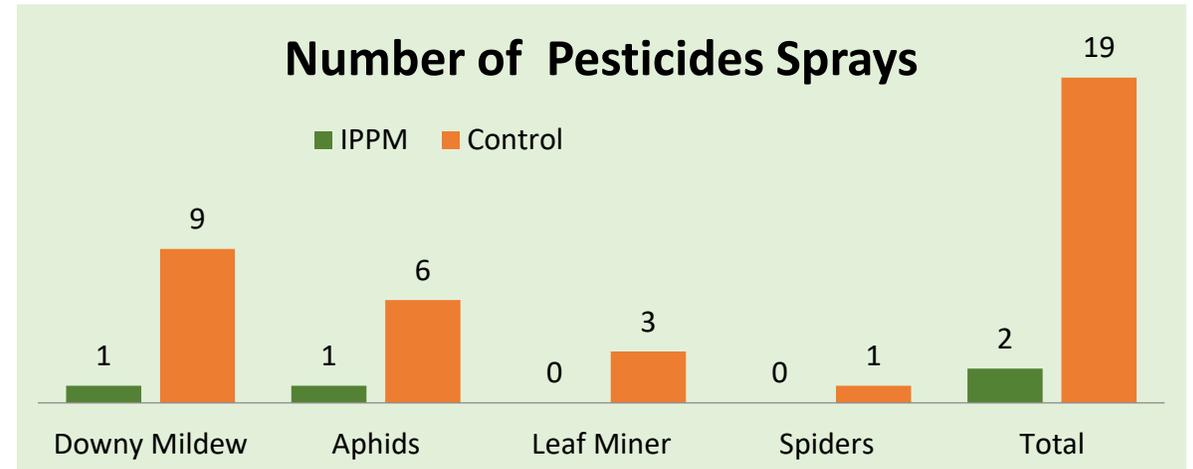
Insect-proof net



Double doors



Aphid lion larvae feeding on aphids



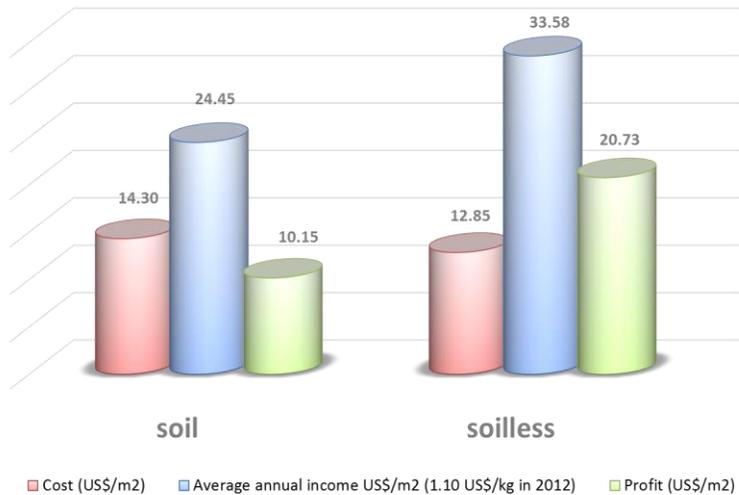
Dhamar, Yemen

Introduced by ICARDA, IPM is Widespread in All Seven Countries

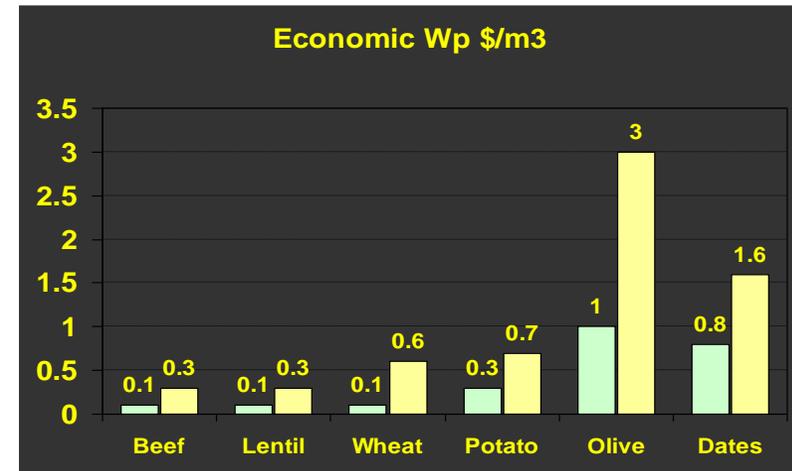
Multi-criteria and Trade-Off analysis of Technologies

Land Productivity

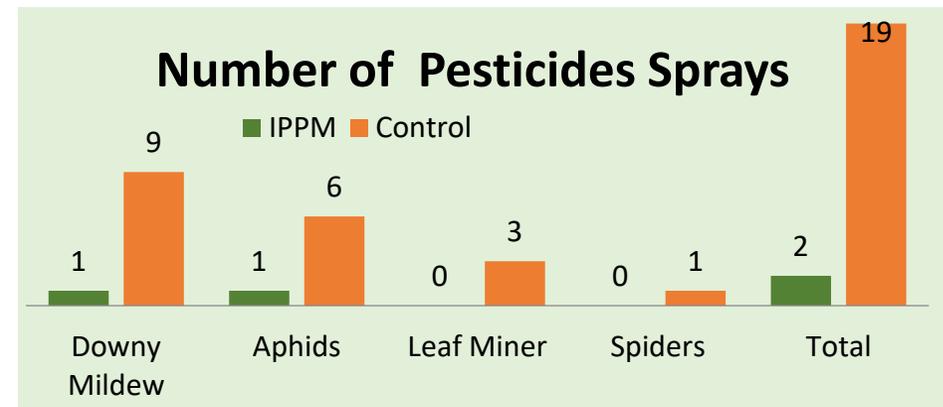
Financial indicators of soil and soilless (Hydroponics) for cucumber grown under cooled greenhouse (US\$/m²)



Water Productivity



Health and Biodiversity



2.2. Systems Design and Outreach for Smallholders



- Low cost
- Participatory Design

Integrated Protection & Production Systems

Results

- Reduction in **pesticide use** (e.g. 80% in Yemen)
- Increase in **yield** (e.g. 60% in Oman)
- Increase in **farmers' income** (e.g. 45% in Yemen)
- **Water saving** (50% in Bahrain, Saudi Arabia, Oman, Qatar, UAE)



Introducing Protected Agriculture in Yemen's Mountain Terraces

- **38 farmers** implemented the system
- **Increased yield** (10 fold in cucumber; 5 fold in tomato) compared to open field
- Up to 400% **additional income for farmers** through the cultivation of cash crops
- **Additional jobs**, encouraging farmers to settle in rural areas
- **Introduction of new techniques** of cultivation and irrigation
- **Intensification of** the use of terrace lands



Donor:
French Government
(Food Aid Program, 2005-2007)



Introducing Protected Agriculture in Afghanistan

- **35 greenhouses** established at pilot farms
- **Additional 30** greenhouse established in Kunduz, where growers volunteered to pay 50% of costs
- ICARDA provides technical support and regular visits to the growers' fields



2.3. Capacity Building (2014 – 2017)



- **12 specialized**-training courses
- **15 on job** training courses
- **23 field days**
- **500** farmers, extension agents, researchers trained

Donors: AFESD, IFAD, OFID

Greenhouse Manufacturing Workshop in Kabul 2005

- **15 local technicians**
- **40% reduced in cost** of the greenhouse structure



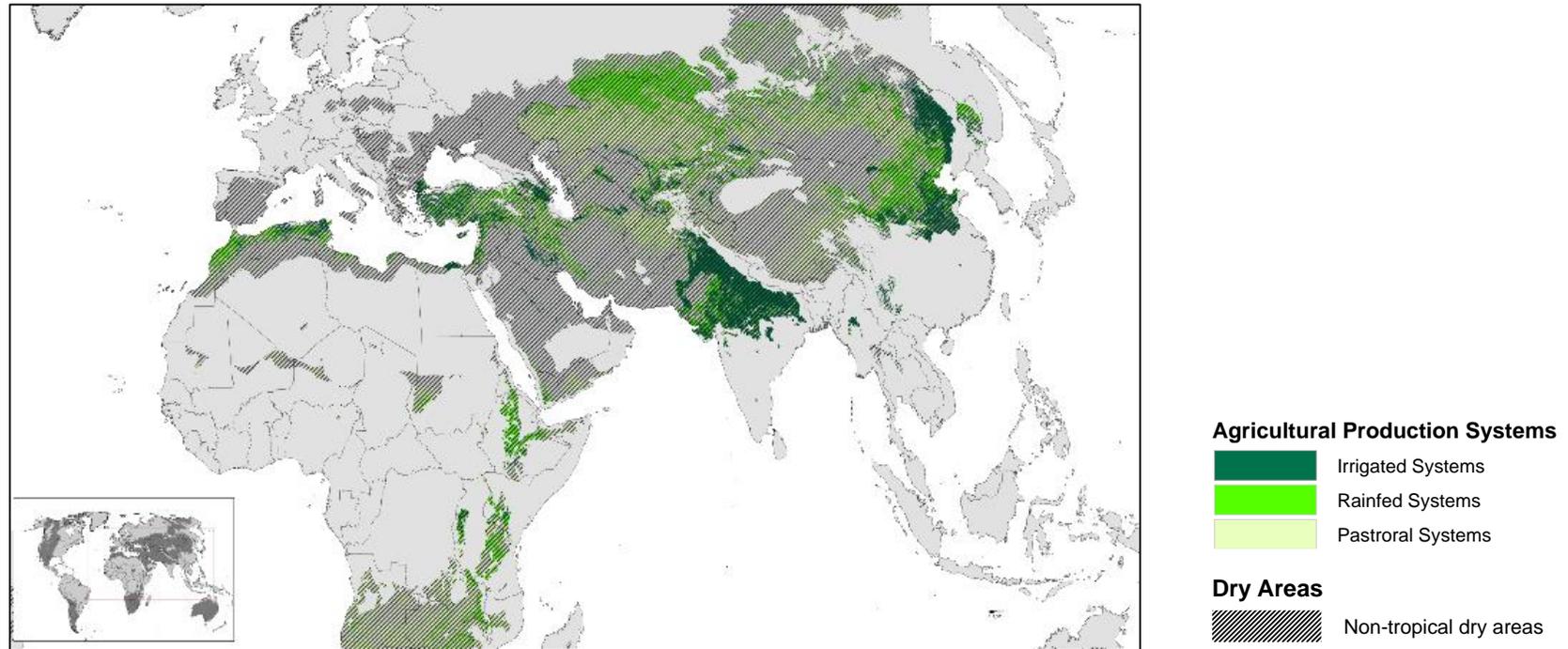
Donor: USAID

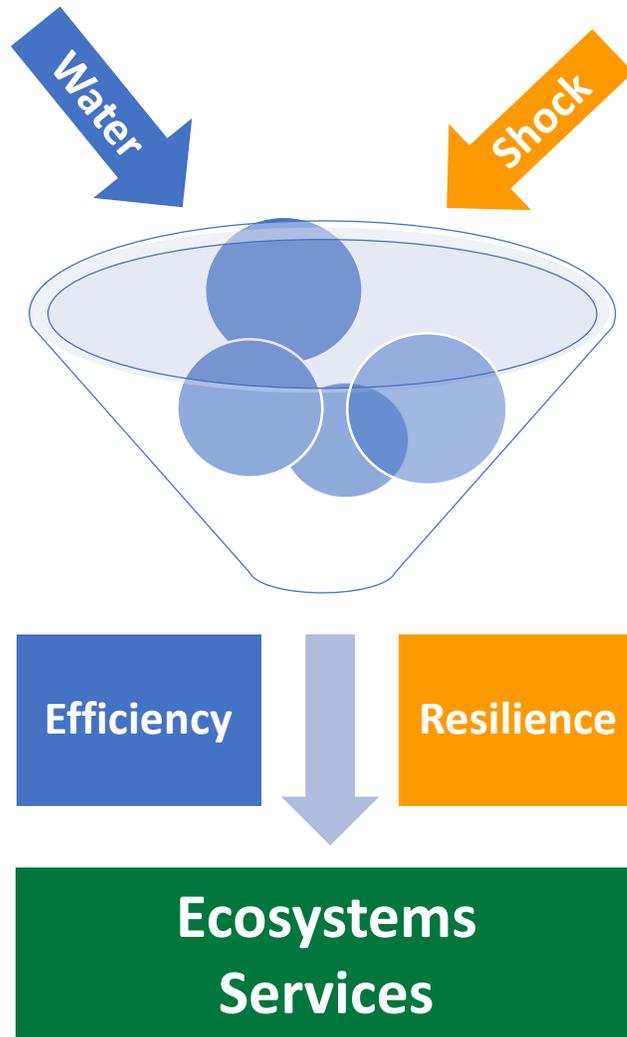
Technology Transfer in Arabian Peninsula 2014-2017



- **325** growers adopted the technology in all countries (12% higher than the project's target)
- Benefited about **1,600 rural households** (directly) and **5,500** indirectly
- **Higher number of growers adopted the technologies** through farmer-to-farmer extension and NARS efforts in Bahrain, Oman, and UAE
- **Number of greenhouses** equipped with soilless-production system reached **1,200 in UAE; 1,000 in Qatar**

3. Way Forward: Promote Irrigation for Integrated-Agricultural Systems in Dry Regions





Research Paradigm

Efficiency and resilience supported by **complexity** (number of components, circularity, managed interactions)

Hypothesis to be tested using systems experiments and farm models

Integrate Vegetable and Grain Crops

Less weeds

Less work



More soil organic matter

Less pests and
disease

Integrate Crops and Fruit Trees in Multilayer Systems



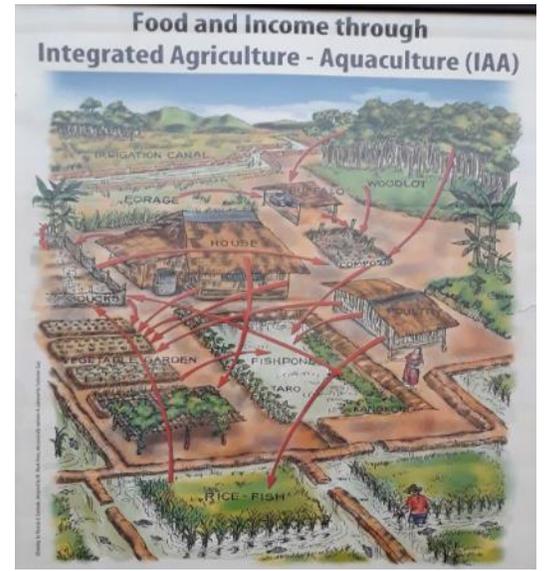
also in soil: sub-surface irrigation



Integrate Crops and Livestock



Also, Why Not Fish?



Combine Food and Energy Production



- **Same biomass** (with the right variety)
- **Less water** used (up to 30%)
- Produce **electricity**

To open the discussion



- **Protected agriculture for smallholders** farming in Dry Areas.
- **Change the vision** in dry areas: “more nutrition and jobs per drop,” instead of “more crop per drop”
- **Sustainability** of irrigated agriculture should be grounded in **diversity**
- **Innovation is at interfaces** between agricultural and food systems
- **Move to farming systems design** from component-/sector-based design
- **Combine** research for smallholders and private sector (big farms, suppliers, food sector)