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The Case For Drip Irrigation

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Agenda

<u>Part I - Overview</u>

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2. The agricultural challenge
3. Water for agriculture
4. Drip irrigation

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5. Research Questions
6. Literature review & Alfalfa
7. Theoretical framework
8. Next steps & references

Overview

NETAFIM I

- The first and leading drip-irrigation company in the world
  - How was the idea born?

…the largest tree in the farm seemed to be growing with no source of water…

The story of water engineer Simcha Blass, 1930's

- Drip irrigation = application of water and fertilizer directly into the root zone of the plant

- First drip device ready by 1959

NETAFIM™
GROW MORE WITH LESS

NETAFIM II

- Kibbutz Hatzerim buys drip patent in early 1960’s
  - Second to best alternative
  - Irony

- **The establishment of Netafim in 1966 by Kibbutz Hatzerim**
  - 1974 – Kibbutz Magal joins
  - 1978 – Kibbutz Yiftah joins
  - 1998 – Netafim Conglomerate
  - 2011 – Permira Investments gains control (66%)

Netafim III

- 50 years of shaping the future
  - Products and smart irrigation solutions
    - Drippers, driplines, sprinklers and micro-emitters
    - Crop management technologies
  - Variety of uses
    - Agriculture, landscape, green-houses
  - Global reach
    - 4000 workers worldwide
    - 2,000,000 customers from 110 countries
    - 28 subsidiaries and 16 factories

- 2013 Stockholm Industry Water Award

The Agricultural Challenge

- "How can the world be fed in the future without putting irreparable strain on the Earth's soils and oceans?" The Economist

Agricultural production must increase by 70% to meet 2050 global demand for food

Forecast by FAO

- Will population growth outpace food production?
  - Malthus pessimistic prediction not yet realized!
  - The role of technology

Water For Agriculture

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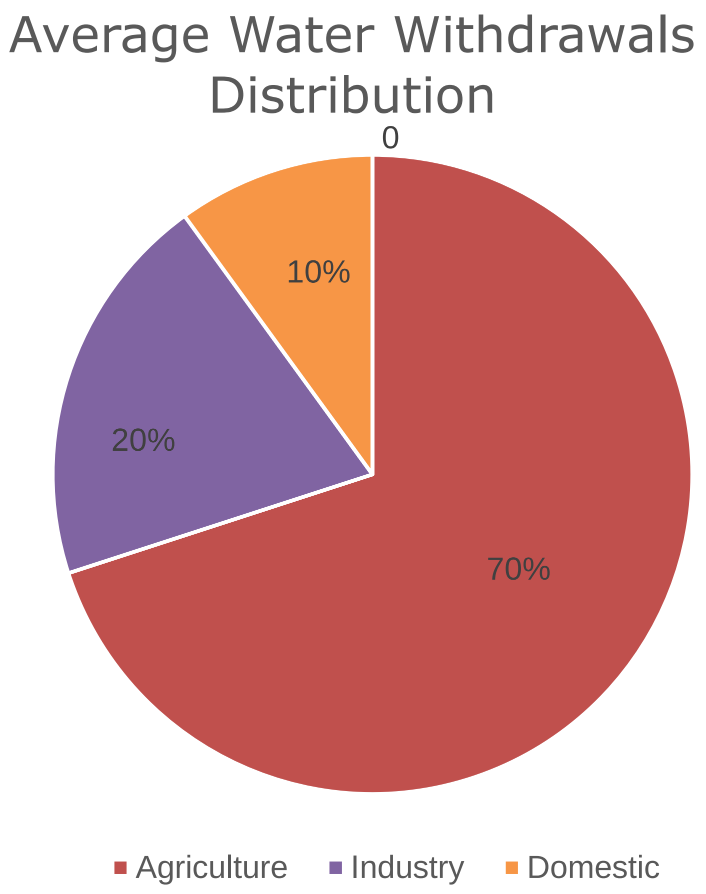

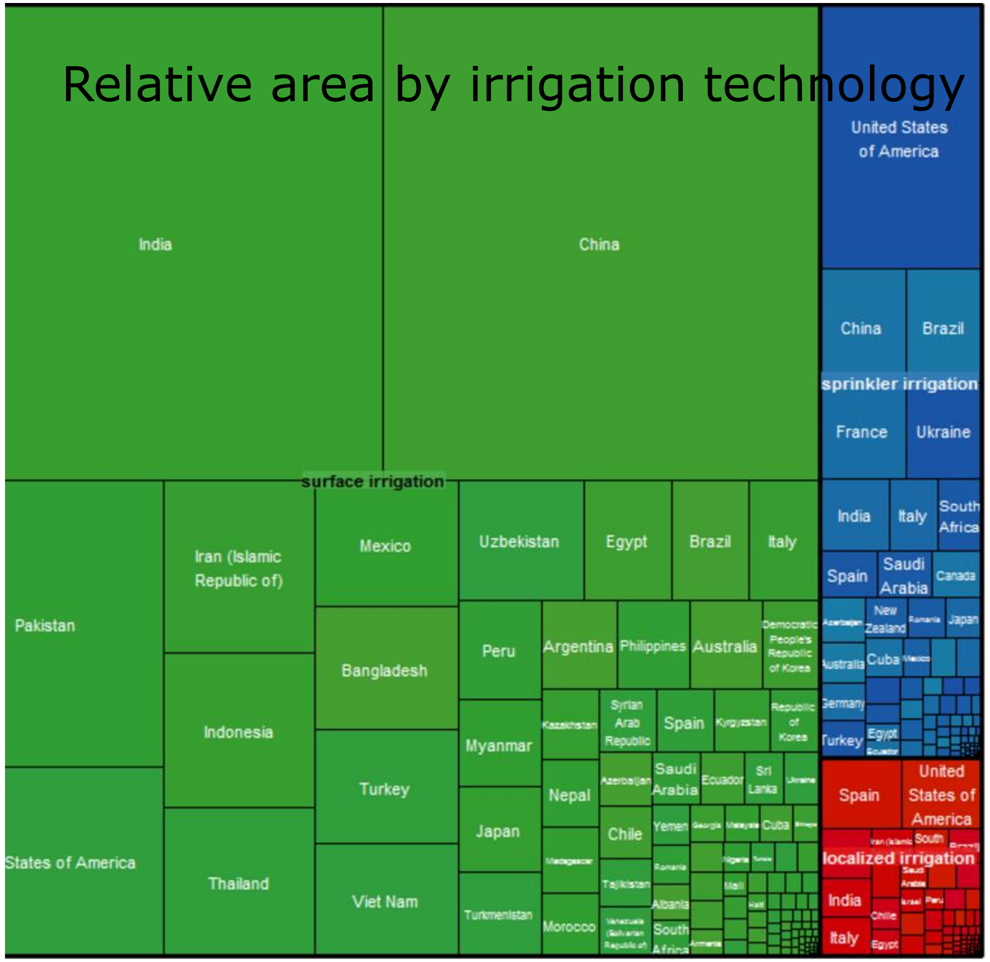

Source: ICID

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Global concerns:		Drip characteristics:
Irrigation is crucial for food security	→	• Higher & better yields • Better protection from weeds and pest diseases
Water and fertile land are scarce resources	→	• Higher water use efficiency • Allows production in lands less suitable for agriculture
Environmental degradation	→	• Less groundwater contamination • Lower GHG emissions • Minimum soil erosion

And yet, high investment costs and ongoing replacement costs make diffusion of drip technology far from over

Internship Assignments

STEP I
DEFINITION OF RESEARCH OBJECTIVES

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How do farm characteristics and irrigation technology characteristics affect Alfalfa farmer's choice of an irrigation system?

In particular, given a set of agronomic features and irrigation technology characteristics

1. Under which conditions will Alfalfa farmers choose to adopt the technology?
2. How will adoption of drip irrigation impact water, energy and fertilizer use?
3. What is the yield effect resulting from adoption of drip irrigation?

ALFALFA – KING OF FORAGES

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- Characteristics
  - Adaptable to various environments, high yield potential
  - Thirsty crop, but also water-use efficient
- Statistics
  - Worldwide: 30 million hectares
  - USA: 140 million tons, USD 8 billion value
  - California:
    - 9% of total US production
    - Production concentrated in Imperial, Kern, Tulare, Merced and Fresno counties
    - Irrigation:
      - 82% - surface irrigation
      - 15% - sprinkler systems
      - 3% - subsurface drip irrigation

Step II
Literature Review - An Example

- "A Model to Assess the Economic Viability of Alfalfa Production Under Subsurface Drip Irrigation in California"
  - Model: Alfalfa yields as a function of seasonal water use (SWU)
    - SWU predicted from CIMIS stations data
  - Alfalfa yields predicted for CA regions
  - Modification factor introduced to capture agronomic variations
  - Cost equations developed
  - Profitability indicator developed
  - Thresholds of profitability calculated for each region
  - Market effects calculated (changes in net profits for industry)

Step II
Literature Review - Another Example

- "The Effects of Well Depth and Land Quality on the Choice of Irrigation Technology"
  - Model: profit is a function of land quality and well depth
  - Two problems solved:
    - Water use choice under traditional and modern technologies
    - Profit maximization given water use choice
  - Response of variables (water and energy use, output) to changes in parameters (land quality, well depth, prices)
  - Two production functions: quadratic, Cobb-Douglas (differs in elasticities)

Step III
Analysis of Insights

- Various assumptions made in related studies:
  - All costs (other than fixed irrigation system costs) are the same across technologies
  - Groundwater is used for irrigation
  - Irrigation effectiveness depends only on land quality
  - Output is a function of effective water and land quality
  - No uncertainty / risks involved in adoption

- Different sets of assumptions may bring different results
  - How to create a model realistic enough but not too complicated?

Step IV
Brainstorming Potential Directions

- What is missing in the literature?
  - Impact of irrigation system specifications on benefits from adoption
  - Impact of different types of water (recycled, brackish, etc.) on benefits from adoption
  - Impact of adoption on basin water level
  - Inclusion of dynamic / uncertain elements
  - Focus on alfalfa

STEP V
THEORETICAL FRAMEWORK

- Assumptions
  - Choice between traditional (gravity-based) and modern technology (drip)
  - Farmers are profit-maximizing agents

- Model outline
  - Calculate profits under each technology
  - Quantify effects from adoption (yield, water, energy, GHG emissions)
  - Aggregate to predict adoption patterns
  - Quantify industry-wide effects

Profit = difference between revenues and costs

- Revenues = Price * production function
- Production is a function of several agronomic features
- Costs include irrigation system fixed costs and variable costs (e.g. energy)

Next Steps

- Work with Prof. David Zilberman and Netafim
  - Determine agronomic features to be included
  - Determine irrigation system characteristics to be included in analysis
  - Match expectations
- Develop the mathematical model
- Organize data (farm-level, GIS)
- Analyze results
- Publish report

References - Research Papers

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