Economic Feasibility of Alternative Crops in Arid and Semi-Arid Areas: The Case of Tomato in Southwest Kansas

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Outline

- Research framework – question and objectives
- Research methods
- Preliminary results

Motivation: Conserving the Ogallala

Ogallala is depleting

At least that is what the Kansas Water Office and Kansas Geological Survey tell us

We need to conserve water without giving up income

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Prime Objective

Evaluate the economic feasibility of migrating from traditional crop production to alternative crops and production technologies with the view of sustaining farmer incomes

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Assumptions

- 20-year KFMA average net farm income (2004-24) = $118,314
- Typical acreage for Southwest KS farmer = 1,467.2 acres
- Typical crops planted: Corn (29.5%), Sorghum (22.6%), Soybeans (4.5%), & Wheat (43.4%)
- Average irrigation water used for typical crops on typical acreage = 15,018 ac-in
- Can we find a crop and production technology that will produce at least the average income with much less water requirements?

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Greenhouse Tomato: An Alternative?

Almería, in southeastern Spain, is one of the driest places in Europe

It has harness its groundwater and sunshine to become a major hub of greenhouse agriculture in the world

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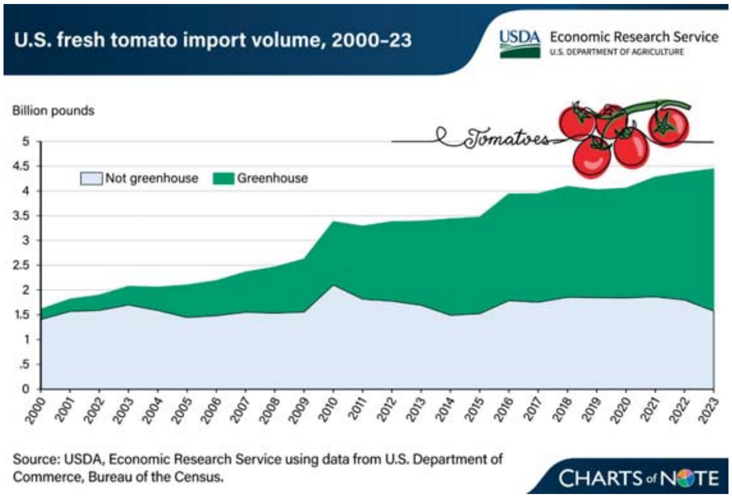
Greenhouse Tomato: An Alternative?



- Since 2000, U.S. fresh tomato imports ↑176%
- Greenhouse share of imports:
  - Early 2000s → **14%**
  - Early 2020s → **60%**
- Growth driven mainly by **Mexico's year-round greenhouse expansion**

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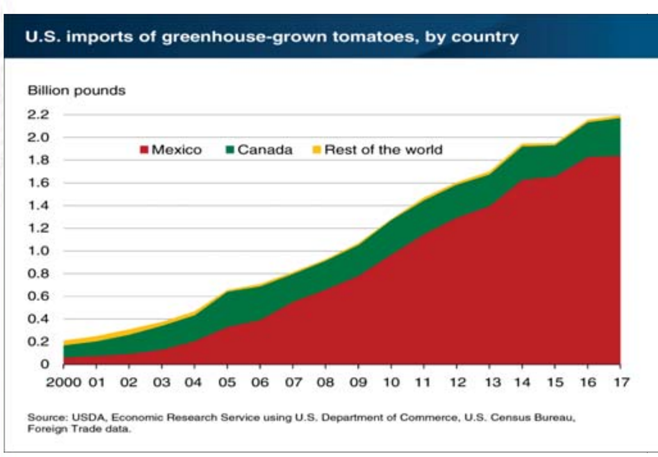
Greenhouse Tomato: An Alternative?



In 2024, United States imported $3.63B of tomatoes

Opportunity for import replacement and contribute to addressing the trade deficit

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Economic Feasibility of Greenhouse Tomato Production in Southwest Kansas

- Given the opportunity for import replacement and the opportunity to save water, is greenhouse tomato production economically feasible?
- Considerations:
  - CAPEX for a greenhouse
  - OPEX for a greenhouse
  - Yield and price assumptions
  - Cost of marketing

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Economic Feasibility of Greenhouse Tomato Production in Southwest Kansas

- CAPEX
  - Greenhouse
  - Heating and cooling system
  - Pumps & plumbing system
  - Irrigation & production system
  - Electricals
- OPEX
  - Seed
  - Fertigation
  - Fungicides and insecticides
- Revenue
  - Yield: 10-60 pounds/plant/year
  - Price: $0.50-$2.50/pound
  - Marketing cost = 15% of price/pound

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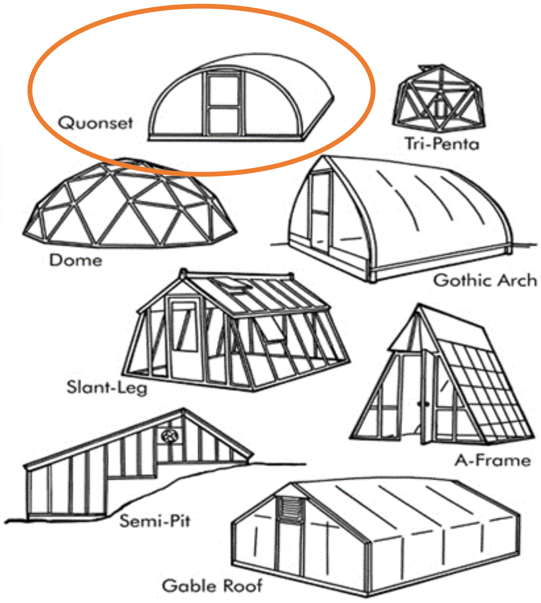
Types of Greenhouses



- Range: $5-$50/sf
- We used the Quonset at $10/sf
- Total square footage per greenhouse = 2,304 sf
- Opex for the Quonset estimated at $2.52/sf
- Square feet/acre = 43,560 sf adjusted for spacing between houses = 43,400 sf
- Number of greenhouses/acre = 19

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Quonset Greenhouse was the Cheapest Option for Desired Solution

Polyethylene-covered (Cheapest option)

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Greenhouse Economics

Cost Side

Total sf = 43,400

- CAPEX ≈ $10/sf
  - Total CAPEX = $432,929.69
- Direct Cost = $2.52/sf
  - Total Direct Cost = $109,253.47
- Fixed Cost = $63,988

Revenue Side

- Yield per plant = 20 lbs.
- Total Production = 200,000 lbs.
- Price per lb. = $1.31
- Gross Revenue = $262,000
- Net Revenue = $61,567.34

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Financial Analysis: NPV at 8% over 20 Years

NPV	$171,547.56
IRR	13%
PBP (years)	7.03

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Sensitivity Analysis

Sensitivity	Project	Limit
Yield (lb.)	20	18
Price	$1.31	$1.22
Variable Cost per lbs	$0.31	$0.41
Fixed Costs	$63,988.00	$82,775.63

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Sensitivity Analysis

		YIELD					
	$171,548	10.00	18.12	20.00	30.00	50.00	60.00
PRICE	$ 0.50	$ (1,479,175.52)	$ (1,339,948.78)	$ (1,307,654.53)	$ (1,136,133.54)	$ (793,091.56)	$ (621,570.57)
	$ 0.62	$ (1,373,692.67)	$ (1,148,843.57)	$ (1,096,688.83)	$ (819,684.99)	$ (265,677.31)	$ 11,326.53
	$ 1.22	$ (825,348.25)	$ (155,397.93)	$ (0.00)	$ 825,348.25	$ 2,476,044.76	$ 3,301,393.02
	$ 1.31	$ (739,574.47)	$ 0.00	$ 171,547.56	$ 1,082,669.59	$ 2,904,913.66	$ 3,816,035.70
	$ 1.96	$ (146,067.46)	$ 1,075,267.54	$ 1,358,561.58	$ 2,863,190.63	$ 5,872,448.72	$ 7,377,077.76
	$ 2.61	$ 447,439.55	$ 2,150,535.08	$ 2,545,575.60	$ 4,643,711.66	$ 8,839,983.77	$ 10,938,119.82

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Tomato Water Needs and Output Assumptions

- Tomato water needs = 0.53 gallons/plant/day (176.5 gallons/plant/season)
- Tomato planting density = 10,000 plants/acre
- Based on the foregoing assumptions
  - Total Water Consumed = 0.00644 acre-in/plant * 10,000 plants = 65 ac-in/year

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Based on Our Assumptions

Indicator	Traditional Enterprise
Net Income	$118,314
Land use (acre)	1,467.21
Water (Acre-inches)	**15,018**

The Net Income per ac-in is: $7.89

Indicator	Tomato Enterprise
Net Income	$61,567.34
Land use (acre)	1
Water (Acre-inches)	**65**

The Net Income per ac-in is: $947.2

Tomatoes earn **120× more income per ac-in of water** than traditional crops.

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Based on Our Assumptions

We would need about **2 acres of greenhouse tomatoes** to match or exceed the net income from a traditional farm enterprise

In this scenario water use will reach 125 acre-inches

Traditional vs Tomato Enterprise

Indicator	Traditional Enterprise	Tomato Enterprise
Income	$118,314	$118,314
Land use	1,467.21	1.92
Water (Acre-inches)	15,018	125

Indicator	Saving
Land use	99.87%
Water (Acre-inches)	99.17%

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Thank You

Discussion, Questions and Answers

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Risk and Mitigation

Type of Risk	Source of Risk	Greenhouse Tomato	Mitigation Strategies
Financial	Capital investment	High capital investment setup (structure, climate control, hydroponics)	Long-term financing, public–private partnerships, cost-sharing, gradual expansion
Energy	Heating, cooling, lighting	Exposure to energy price volatility	Invest in renewable energy (solar, biomass), improve insulation, energy-efficient HVAC
Labor	Skilled workforce	Continuous need for trained staff (crop care, IPM, climate monitoring)	Workforce training programs, automation technologies
Climate/Weather	Extreme heat or cold	Protected indoors, but extreme events increase cooling/heating costs	Climate-adapted design (evaporative cooling, thermal screens), emergency backup systems
Pests/Diseases	Indoor outbreaks	Rapid spread risk in enclosed system despite lower pest pressure overall	Integrated Pest Management (IPM), biological controls, strict hygiene protocols
Market	Price & demand fluctuations	Reliant on premium markets; oversupply or imports depress returns	Forward contracts, diversify crop portfolio (leafy greens, peppers), local branding
Technology	System dependency	Failure in fertigation, HVAC, or power can cause catastrophic crop loss	Redundant pumps, backup generators, preventive maintenance schedules

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