Farmers' response to water scarcity, policy, and risk

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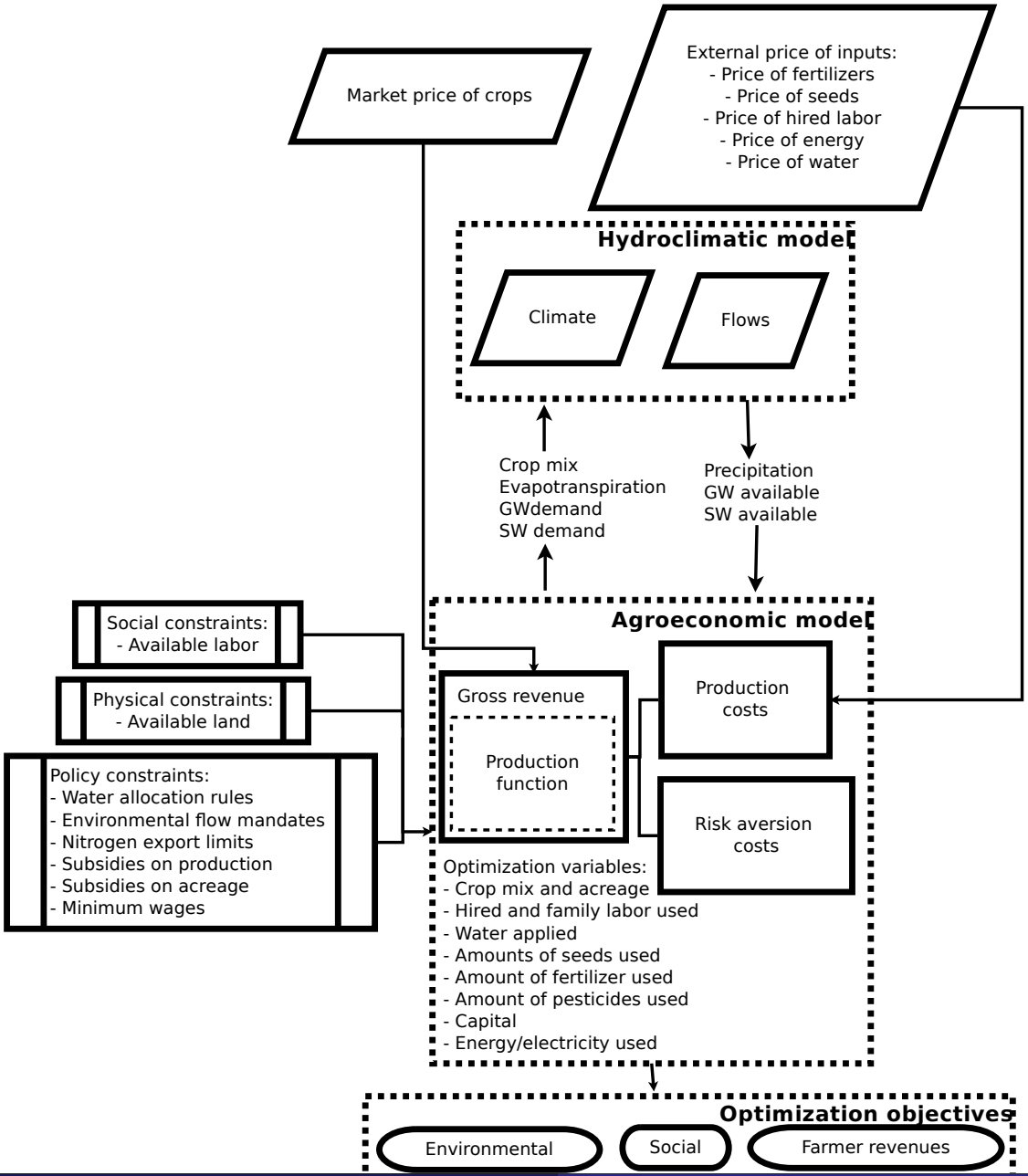
Integrated hydroeconomic analysis

Objectives

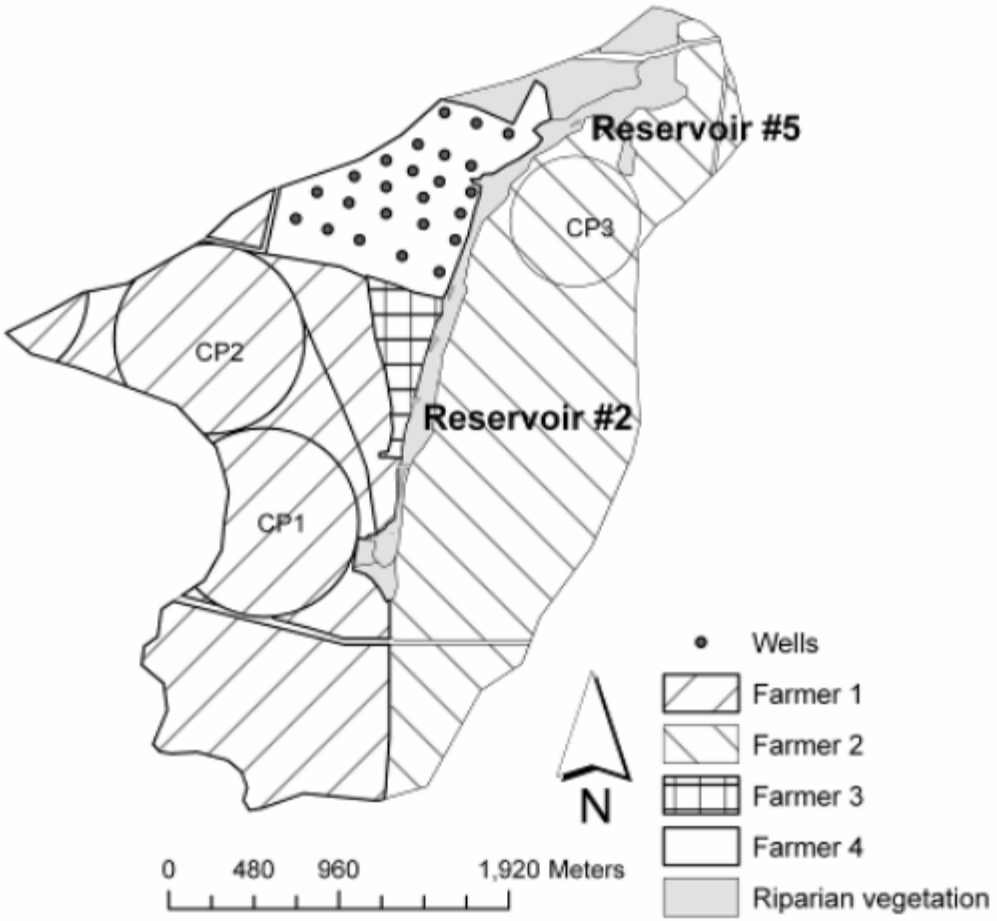
- How do droughts impact crop mix and water use?
- How does agricultural change impact water availability and other water uses?
- How do farmers respond to water policy?
- What water policy maximizes the social and economic benefits of irrigated agriculture while mitigating the negative impacts on other water users

Integrated hydroeconomic model



Results

Effect of access to water: Spatial component



Results

Simulation of scenarios

How do farmers behave in a drought?:

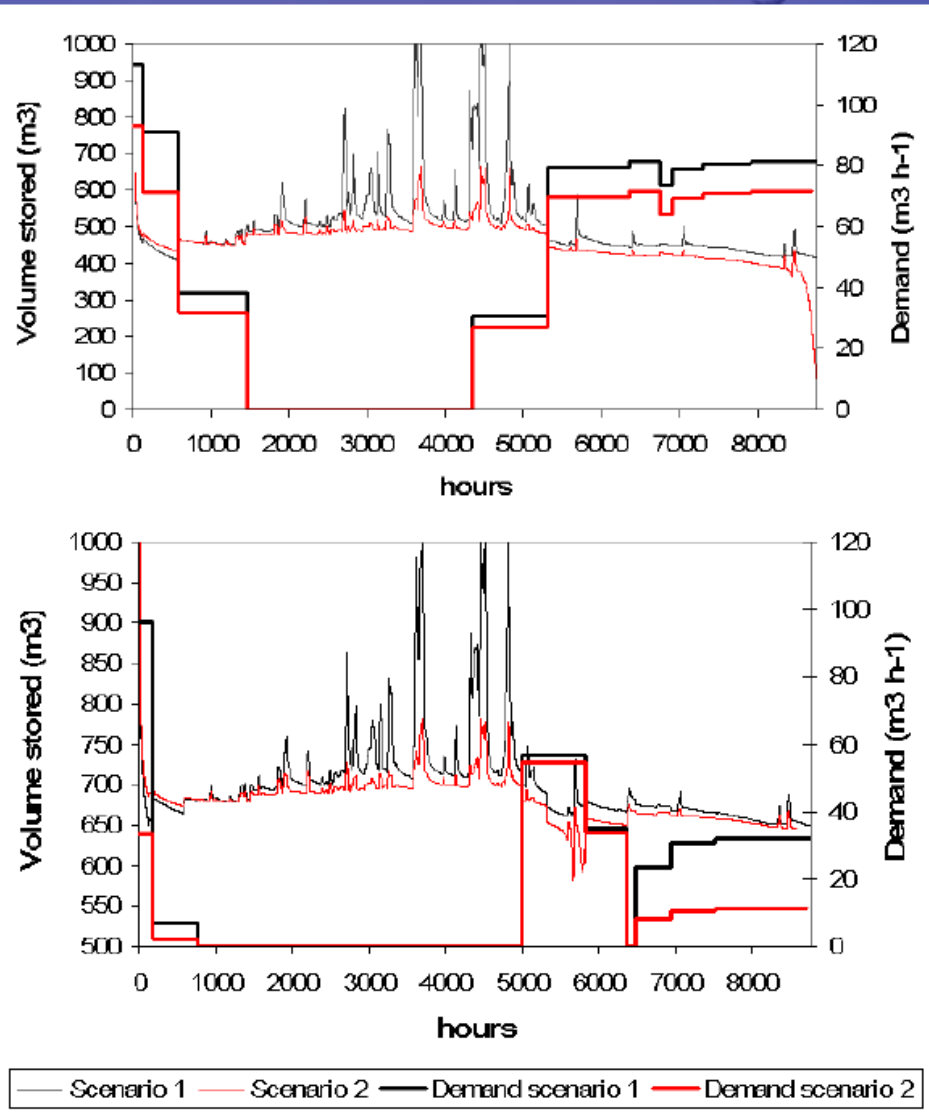
- Baseline scenario: Precipitation and ET in 2004
- Drought Scenario: -40% rainfall +20% increase in ET

Impact of droughts

Change in demand from reservoirs

Reservoir #2

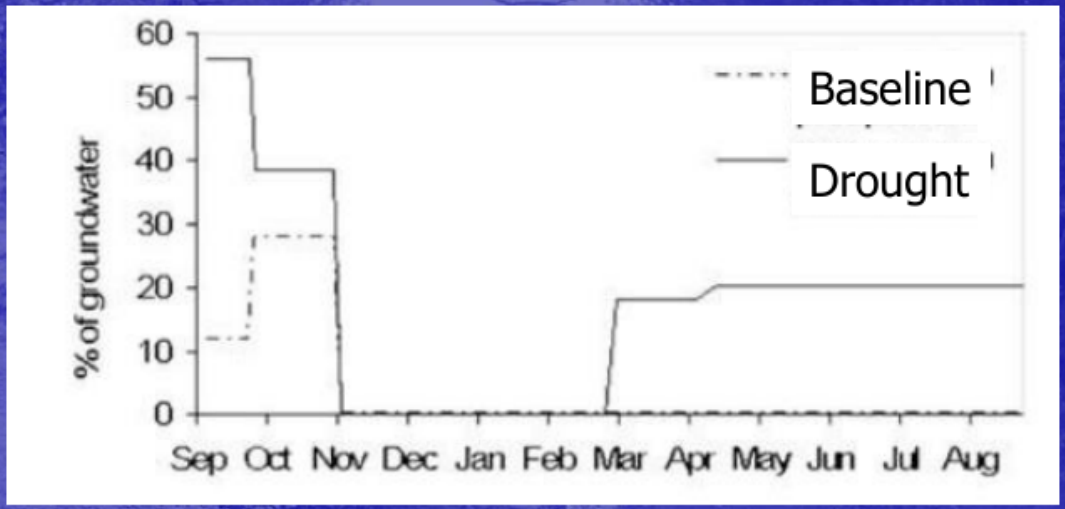
Reservoir #5



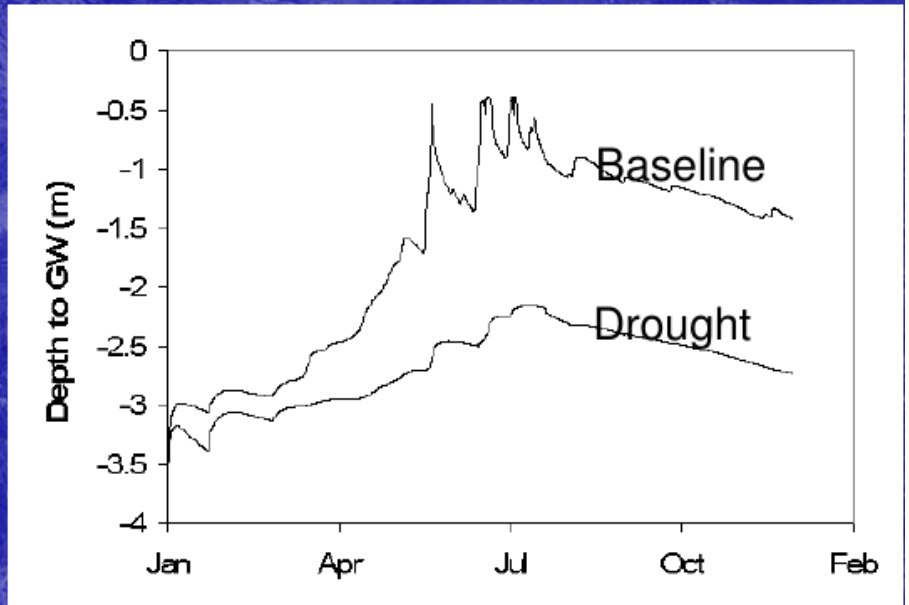
Impact of droughts

Groundwater use (Farmer 4)

Applied water per source

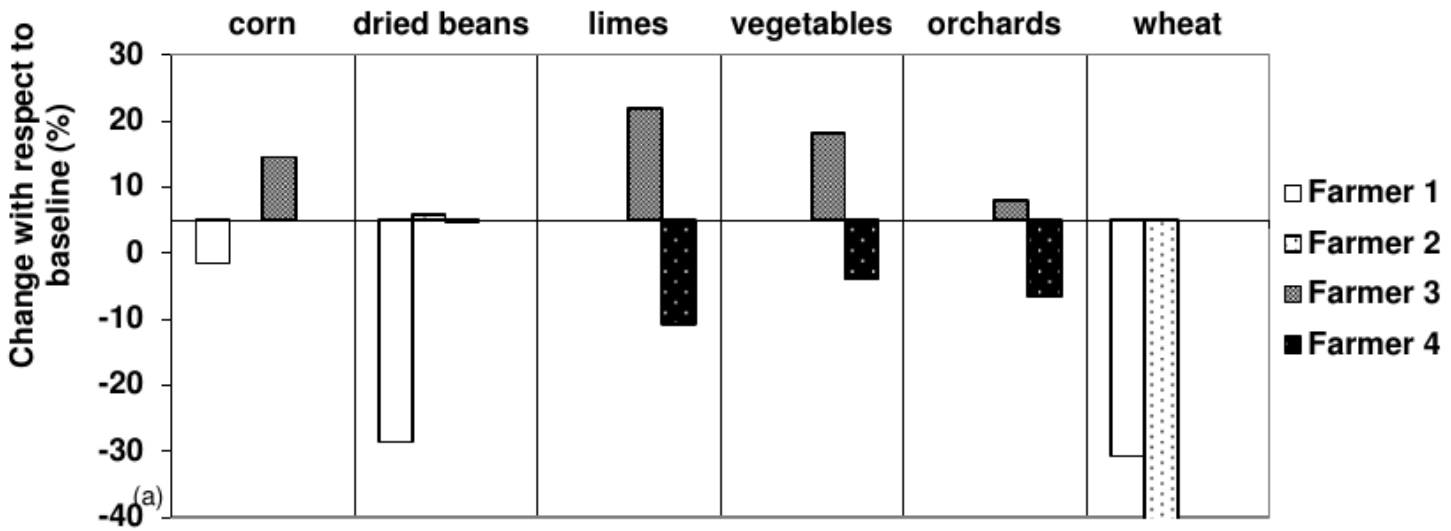


Depth to water table

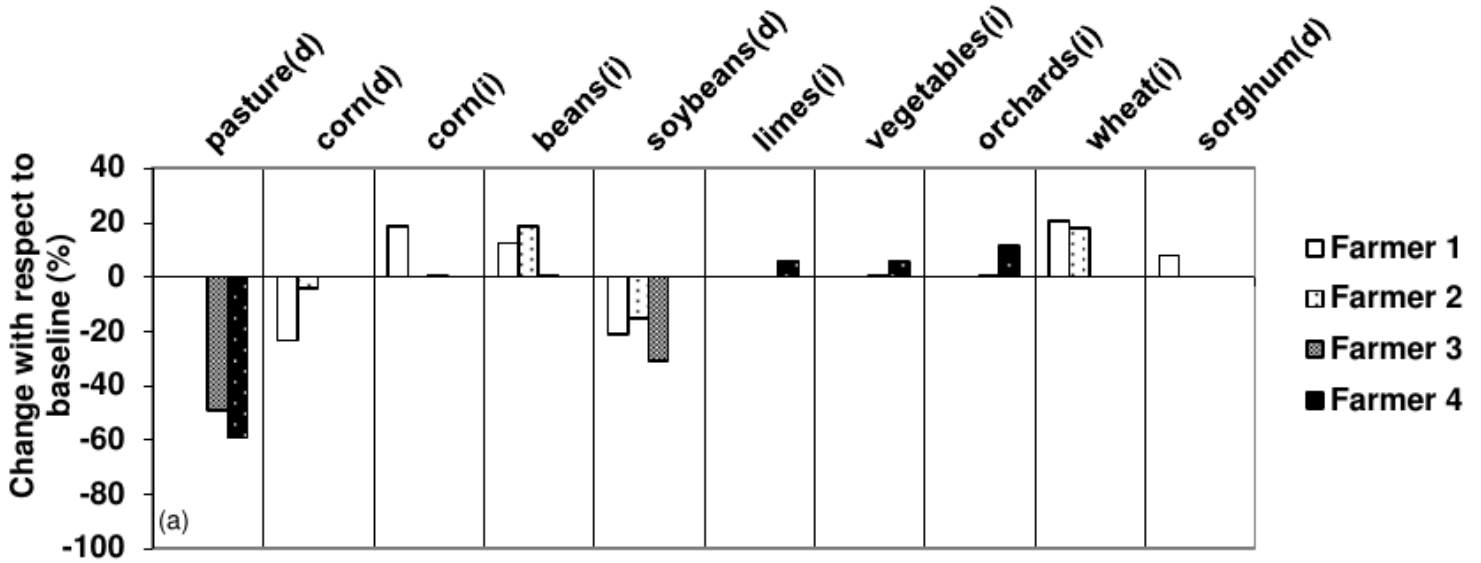


Impact of droughts

Economic effects (water and land use)



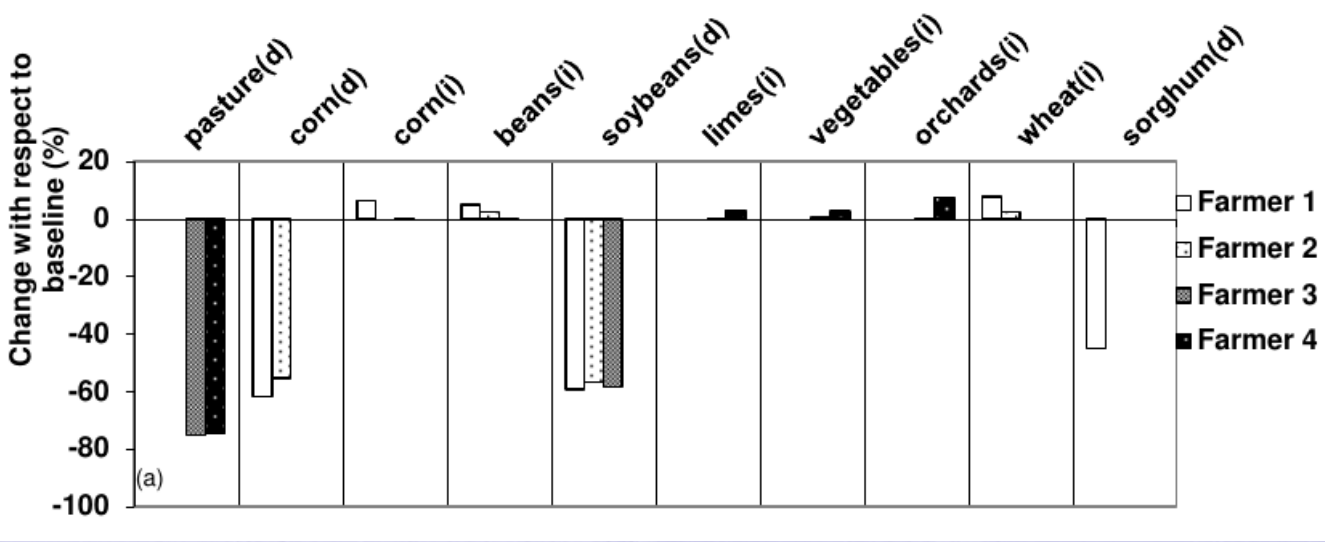
Changes in Applied Water



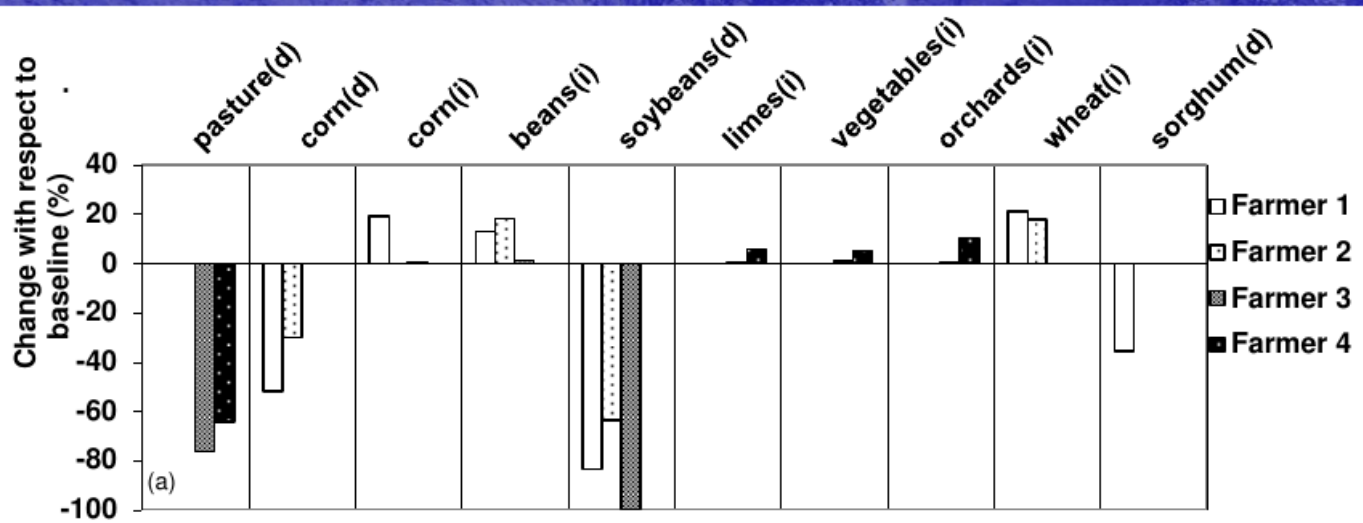
Changes in Land Allocation

Impact of droughts

Economic effects (profits and labor)



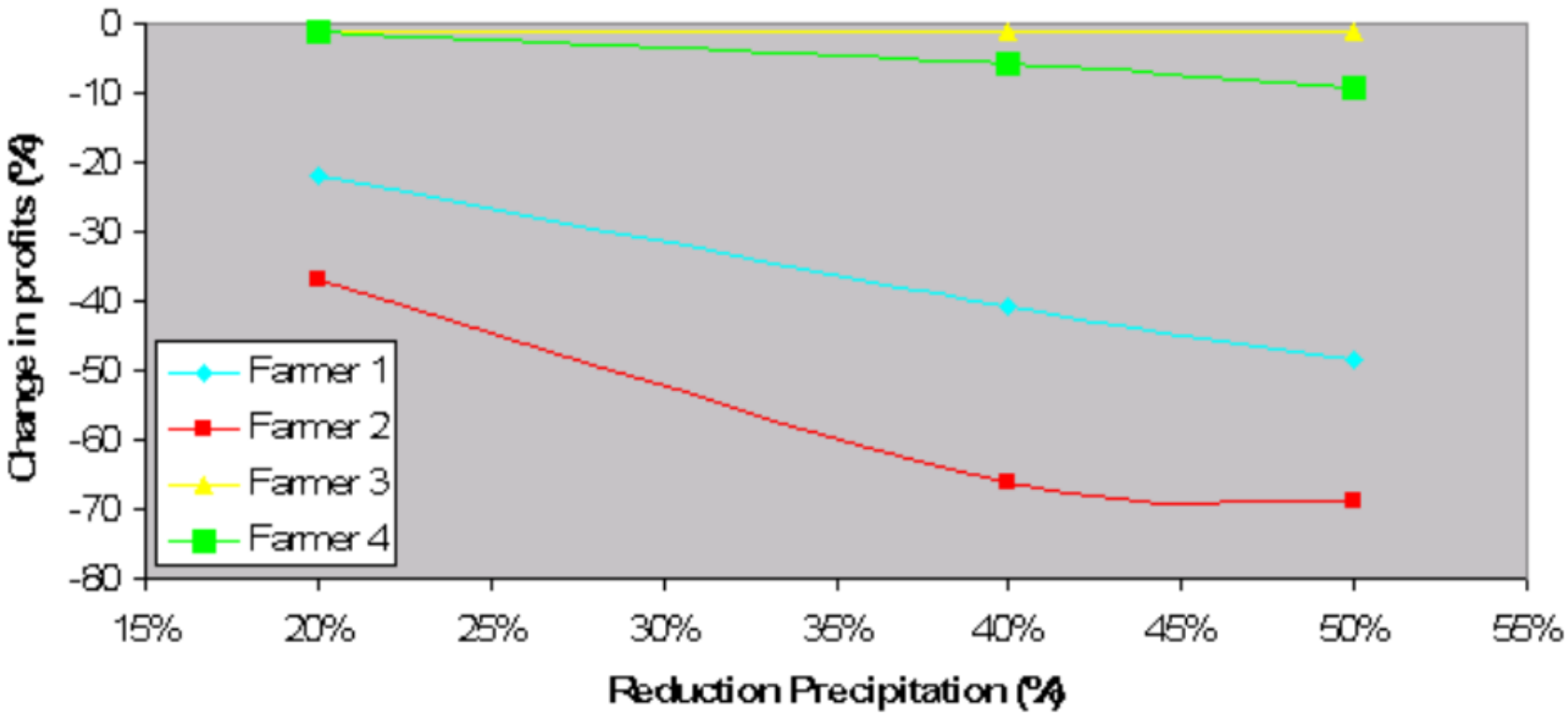
Changes in Profits



Changes in Hired Labor Use

Impact of droughts

Precipitation shortfalls and farm profits



Test run

Farm in Yolo county, CA

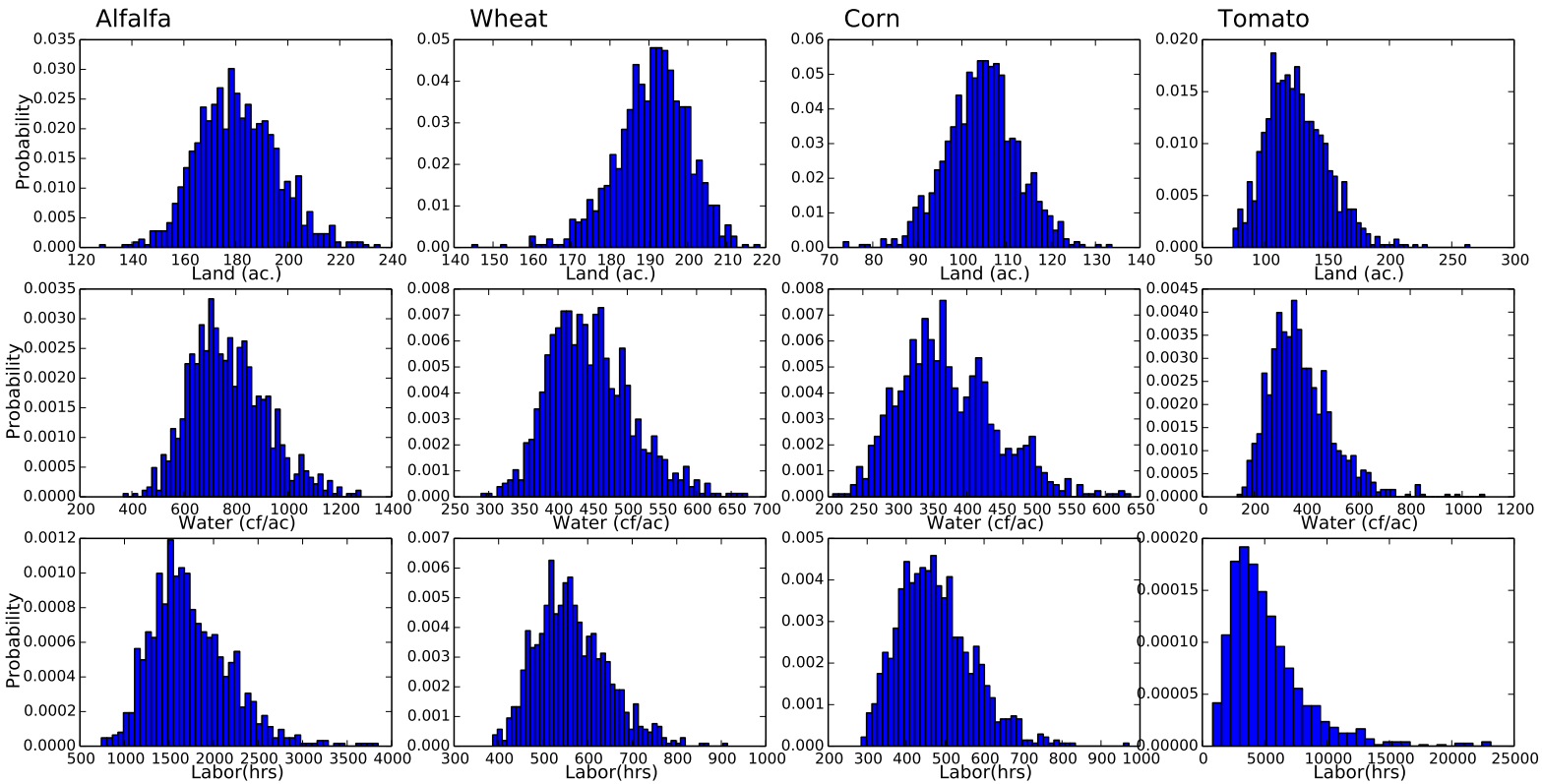
Demonstration for a farm in California

- 610 ac commercial farm
- All crops under irrigation
- Farmer is not water constrained
- Four crops (Alfalfa, wheat, corn, and tomato)
- Three inputs (land, water, labor)

$$X_{i,j} = \begin{bmatrix} & \textit{Alfalfa} & \textit{Wheat} & \textit{Corn} & \textit{Toms} \\ \textit{land} & & & & \vdots \\ \textit{water} & & & & \vdots \\ \textit{labor} & & & \ddots & \vdots \end{bmatrix}$$

Results

Reproduction of baseline observations



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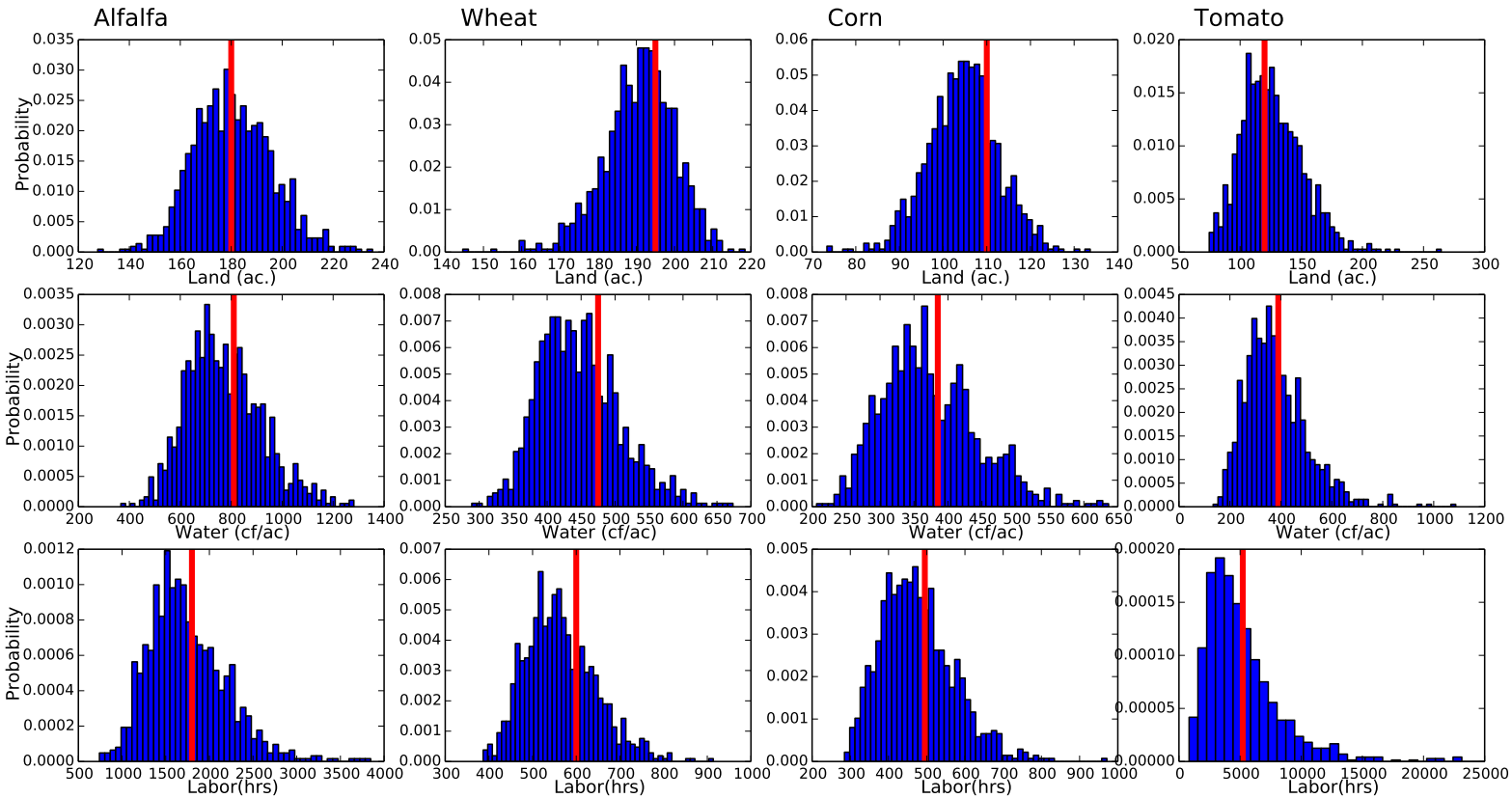


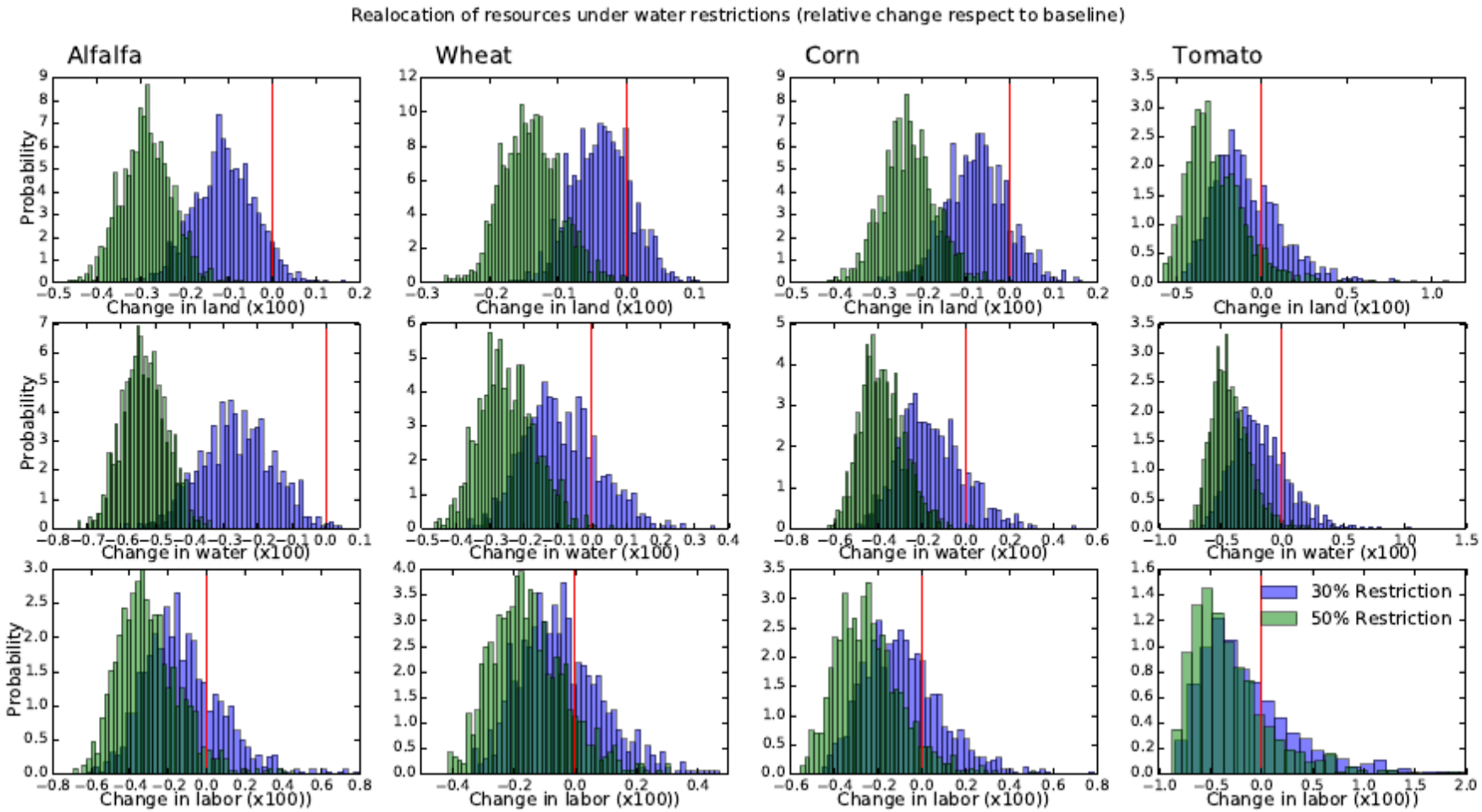
Results

Simulation of scenarios

Test drive: New water allocation rules that results in:
- Scenario 1: 30% reduction in water available
- Scenario 2: 50% reduction in water available

Results

Impact of a reduced access to water



Results

Summary of impacts

	Baseline	30% reduction	50% reduction
Water available	2300	1610	1150
Water used	2060	1610	1150
Shadow value	$0.0	$9.00	$25.3
% loss net rev		-2.76	-11.3
% change hiring		-11.7	-28.9

Conclusions

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- Hydroeconomic models are a valuable tool to inform policy and water management
- Hydroeconomic models may help develop water markets
- Impact of water shortage on rural economies is complex. Losses do not scale with water shortage
- Farmers react to reduced access to water (drought or policy) by reallocating land and water, hiring less or stress irrigating some crops to reduce costs or improve profitability
- Relative location of individual farmers in a region matters. Policy can ensure fair and equal access to water and reduce economic imbalances

THANK YOU