IMPACT OF CLIMATE CHANGE ON COTTON PRODUCTION IN UZBEKISTAN

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INTRODUCTION

- Food Security is defined as "when all people at all times have access to sufficient, safe, and nutritious food to maintain a healthy life."
  - Food availability
  - Food access
  - Food use

INTRODUCTION

- FAO predicts 850 million people are food insecure
- By 2022, the number of food insecure will increase by 37 million
- 2025 world population is expected to increase to 8 billion

INTRODUCTION

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- Fall of Soviet Union in 1991
  - Institutional structure created no incentive for efficiency
  - Collectivized agriculture
  - Desiccation of the Aral Sea
  - Likely rely on irrigated agriculture to establish food security

INTRODUCTION

- 90% of water resources in Central Asia are used for agriculture
  - Uzbekistan receives 60%
  - Irrigation vs. Hydropower
- Uzbekistan produces cotton, rice, wheat, fruit, vegetables, livestock
- 6th largest exporter of cotton
  - Cotton production quotas

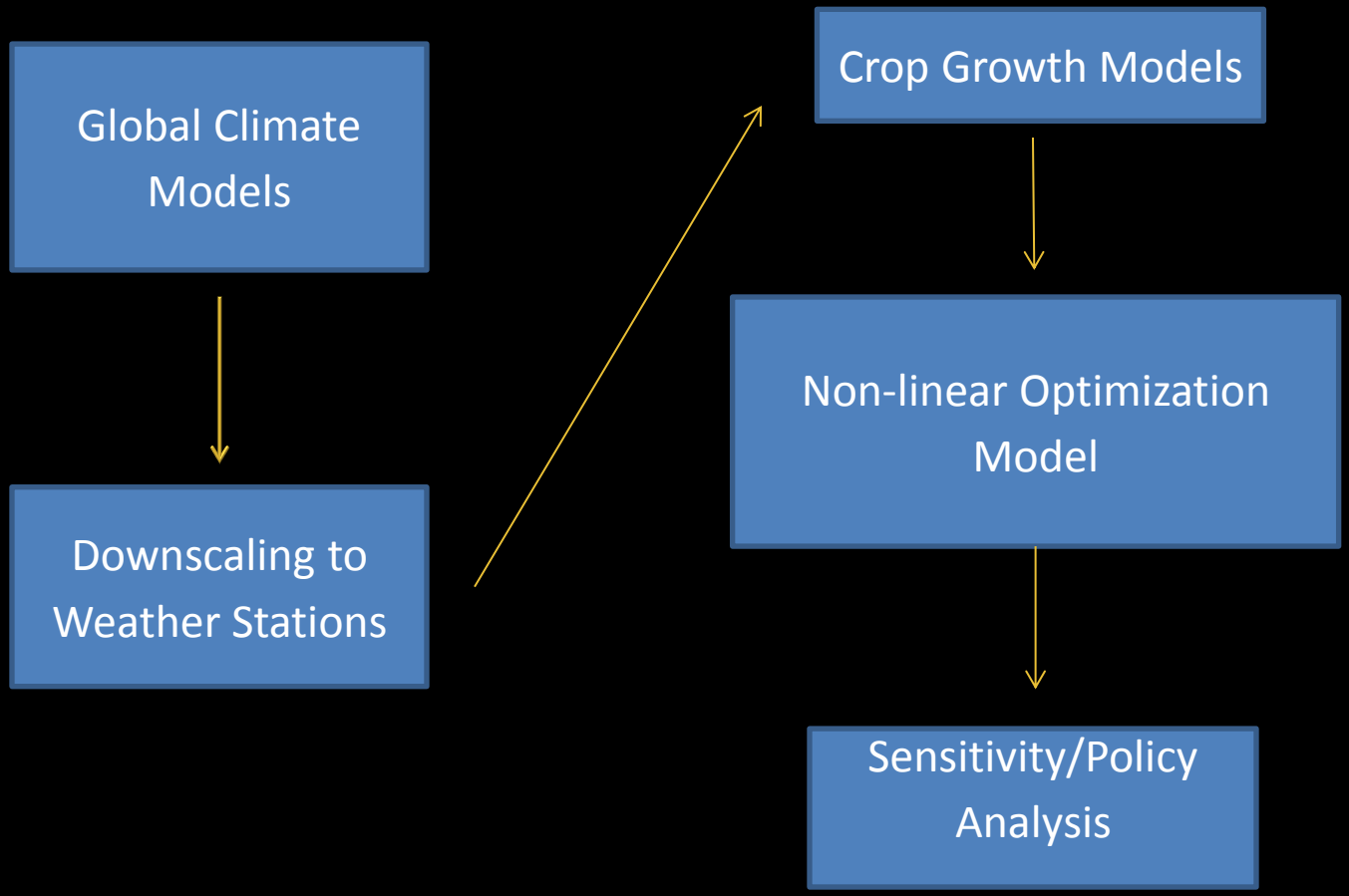
OBJECTIVE

Determine the amount of food and fiber availability in Uzbekistan in the region of Khorezm as a result of changing climate conditions over time

OBJECTIVE

- Examine the uncertainty on the deterministic point estimates from downscaled climate projections
- Evaluate the relationship between crop yields and water for each crop produced
- Estimate optimal cropping choices to maximize profits in the face of limited resources
- Determine the impacts of policy-induced market distortions given projected climate change impacts.

METHODS AND PROCEDURES



METHODS AND PROCEDURES

- Downscaled Climate Projections
  - Nine GCMs, 73 weather stations
  - Tmin, Tmax, and Precipitation
  - 2 RCP scenarios: 4.5(low) and 8.5(high)
  - Three time periods:
    - near term (2012-2039)
    - mid-century (2040-2069)
    - century (2070-2099)

METHODS AND PROCEDURES

- Monte Carlo simulation was performed on daily observations
- Time paths were created using the mean from the previous day and the effect of a random draw

$$T_i = T_{i-1} \pm \widehat{\delta_i},$$

- Used 100 iterations

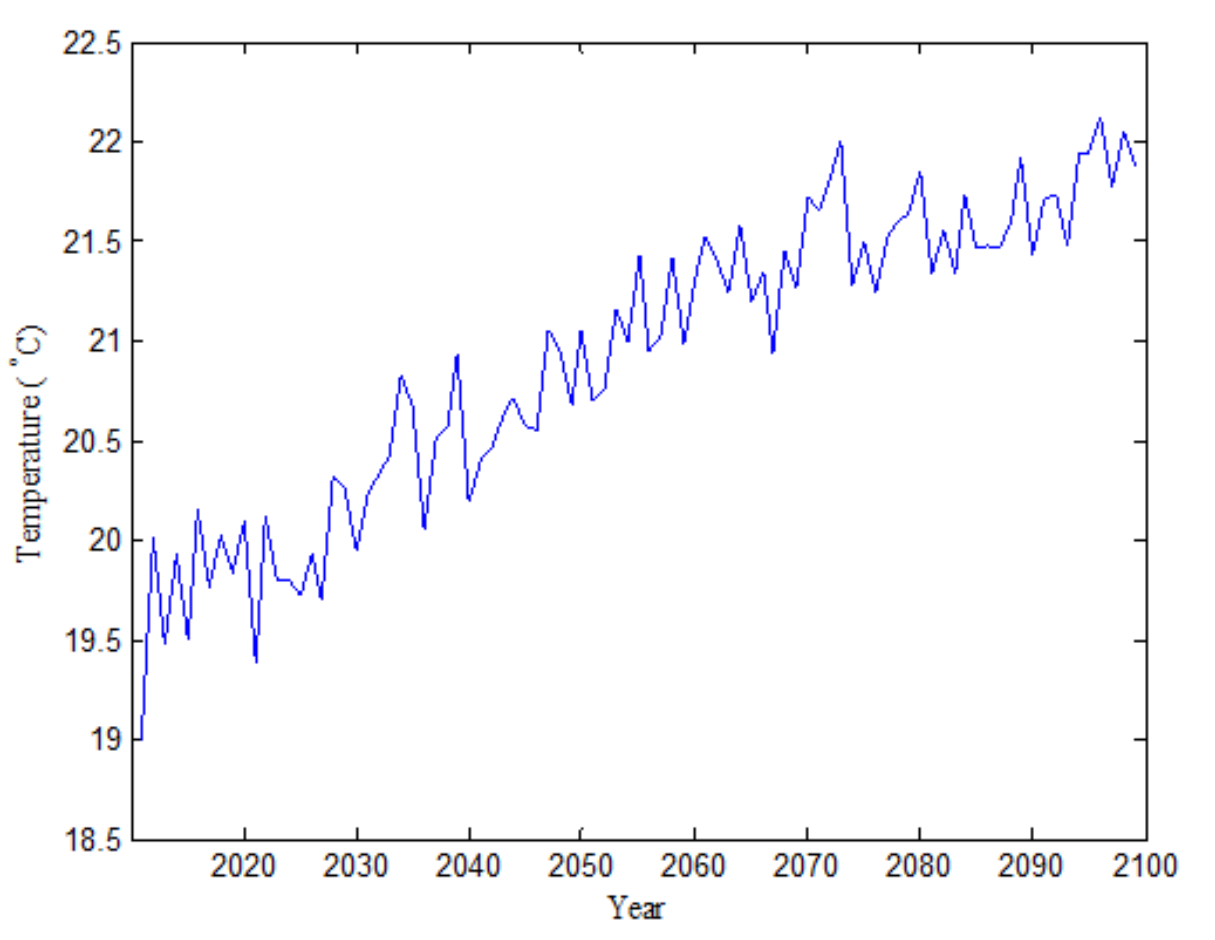
METHODS AND PROCEDURES

- Draw from normal distribution to generate shock values using means and variances from a random walk without drift:

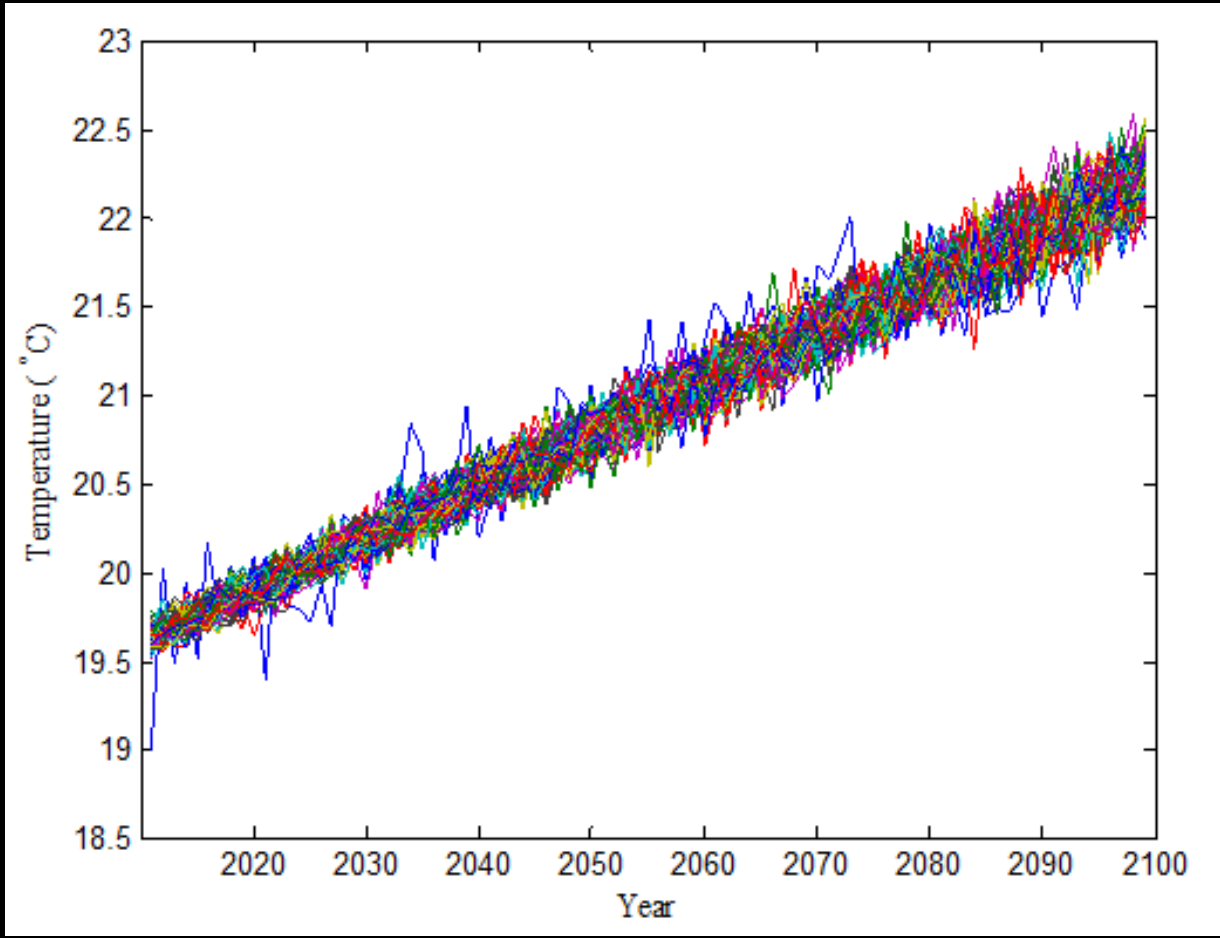
$$Y_t = Y_{t-1} + \varepsilon_t$$

- Sine wave for seasonality

METHODS AND PROCEDURES



METHODS AND PROCEDURES



METHODS AND PROCEDURES

- Crop Production Functions for 4 crops: Cotton, Rice, Wheat, Tomatoes
  - DSSAT
    - 30 of the 100 Monte Carlo climate simulations were used as an input
    - Calibration: soil type, planting dates, planting methods, plant population at seeding, row spacing, planting depth, irrigation levels, and fertilizer treatments, etc.

$$Y = \beta_1 X_1 + \beta_2 {X_1}^2$$

METHODS AND PROCEDURES

- Non-Linear Optimization model
  - Simulate reservoir outflows
  - Constraints added to restrict rice acreage and a cotton production quota
- Performed 2 scenarios
  - Baseline
  - Removal of the cotton quota

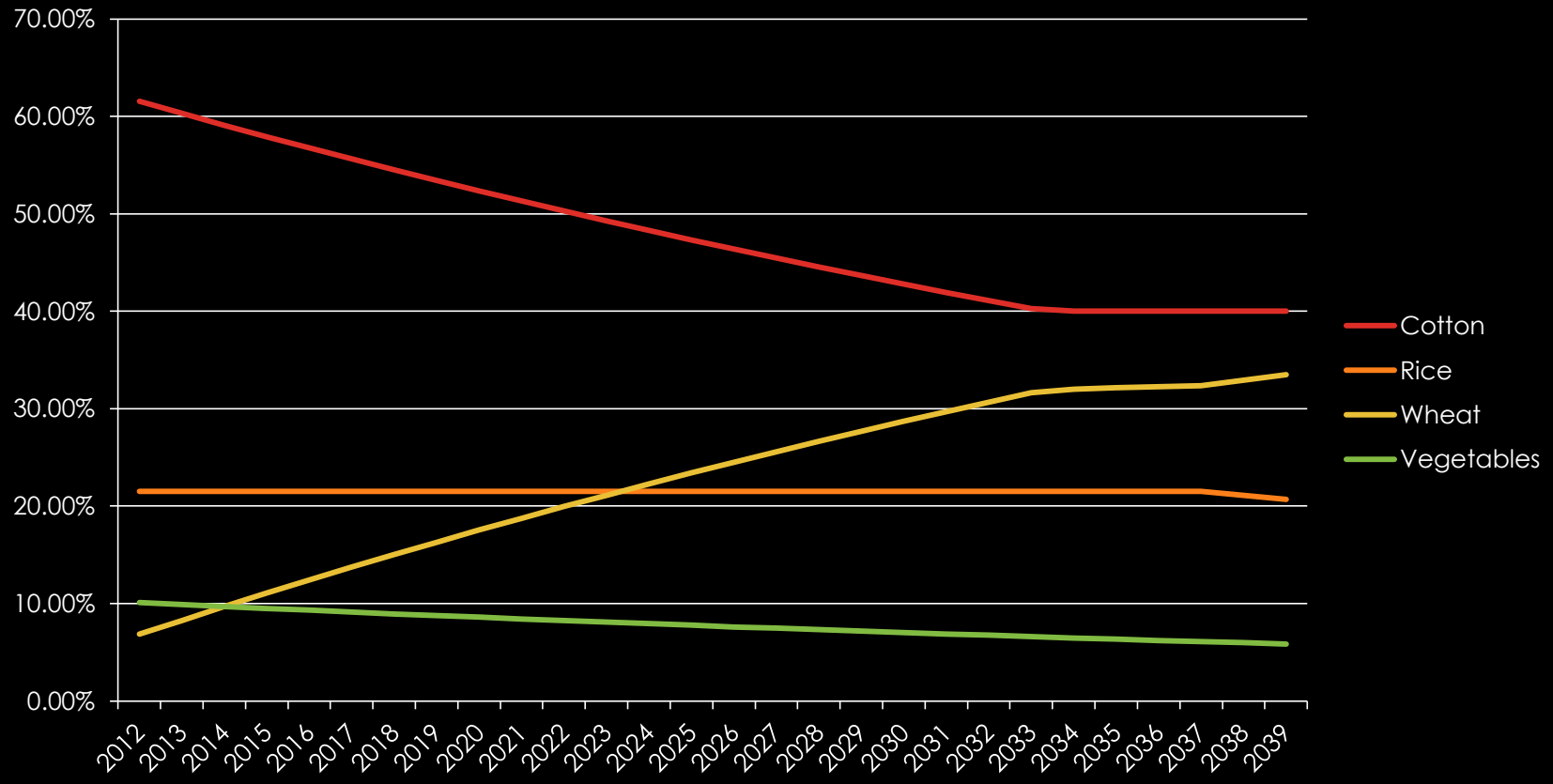
BASELINE YIELD RESULTS

	Cotton (lb/ac)	Rice (bu/ac)	Wheat (bu/ac)	Vegetables (lb/ac)
Near 4.5	1338	91	55	700
Near 8.5	1319	68	60	610
Mid 4.5	1390	55	56	683
Mid 8.5	1457	92	61	615
Far 4.5	1214	64	62	719
Far 8.5	1230	64	58	534

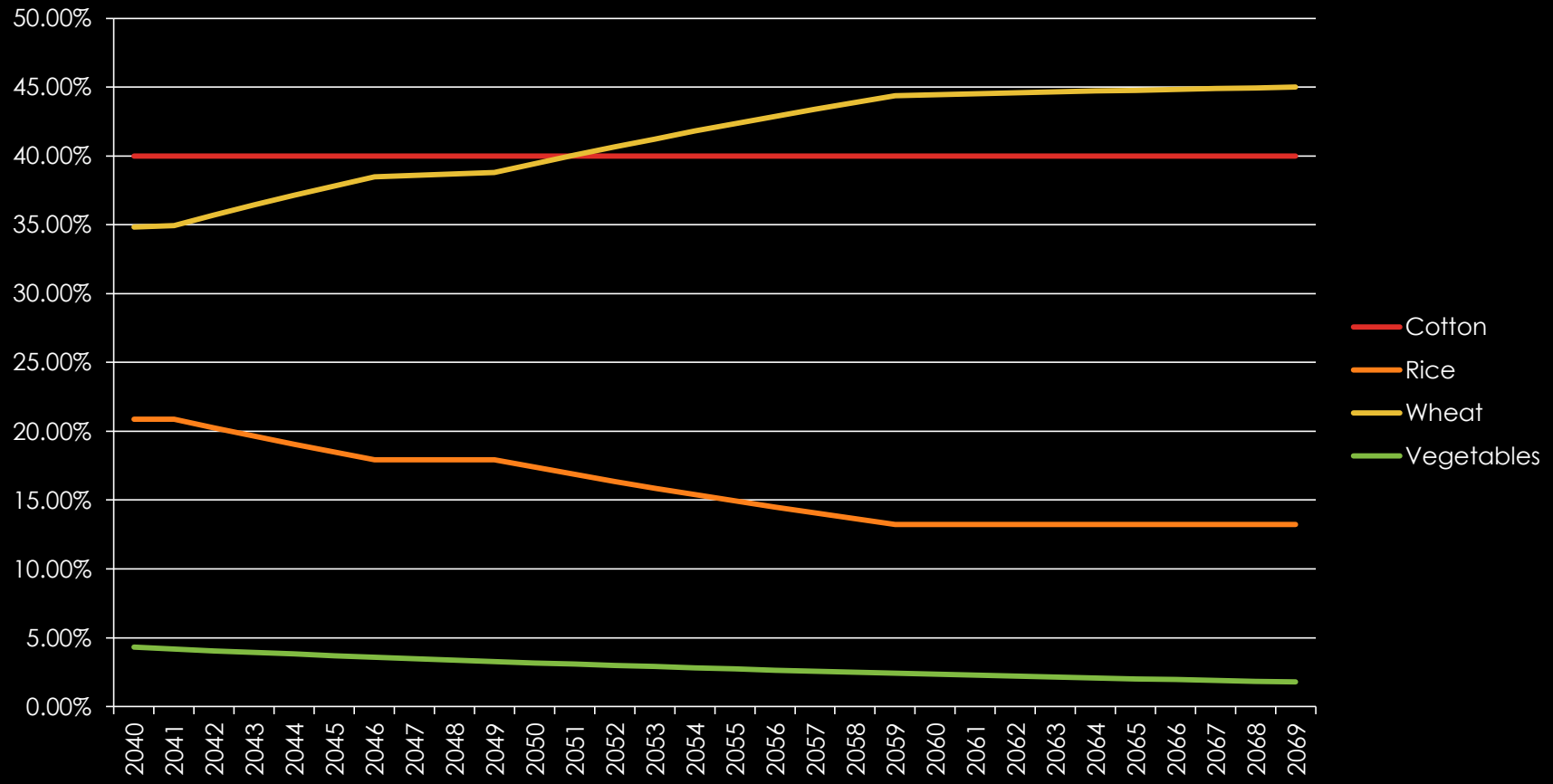
BASELINE NET RETURNS

	Avg Net Returns
Near 4.5	$475.91
Near 8.5	$513.90
Mid 4.5	$392.39
Mid 8.5	$423.25
Far 4.5	$477.73
Far 8.5	$428.16

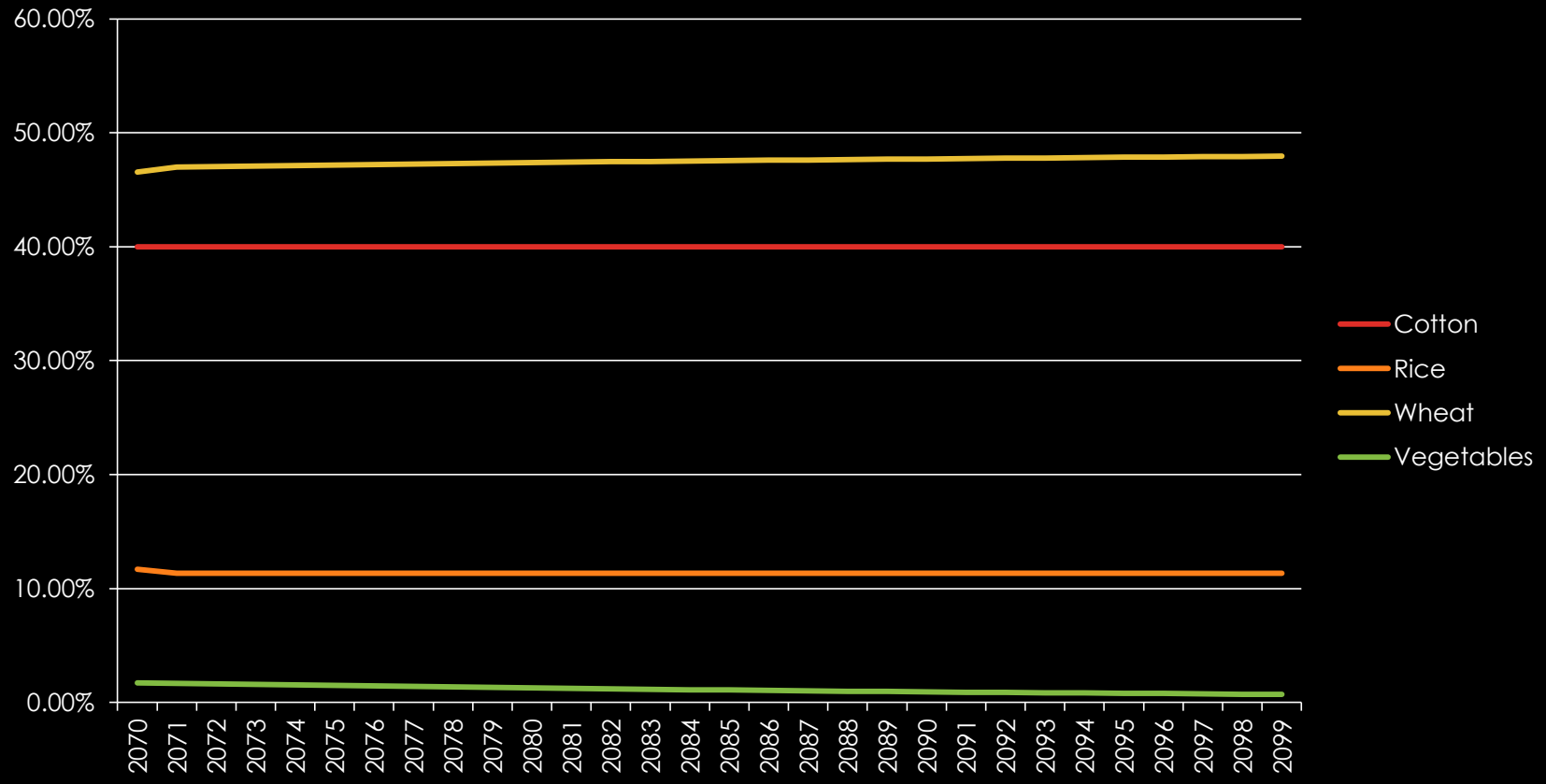
NEAR-TERM BASELINE



MID-TERM BASELINE



CENTURY BASELINE



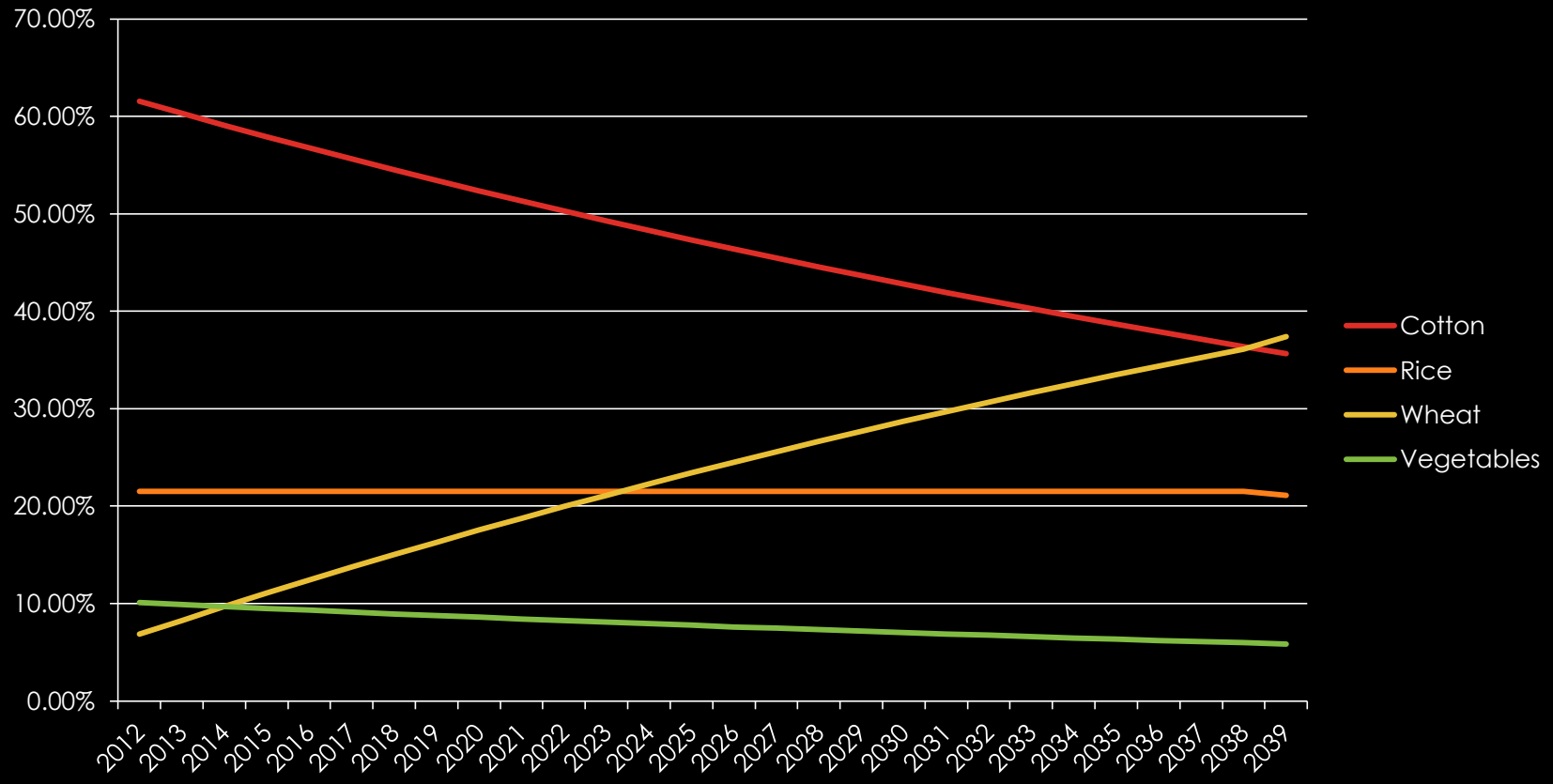
YIELD RESULTS
COTTON QUOTA REMOVAL

	Cotton (lb/ac)	Rice (bu/ac)	Wheat bu/ac)	Vegetables (lb/ac)
Near 4.5	1337	91	55	701
Near 8.5	1319	95	60	683
Mid 4.5	1369	92	56	733
Mid 8.5	1433	93	61	658
Far 4.5	1201	92	62	771
Far 8.5	1205	92	58	539

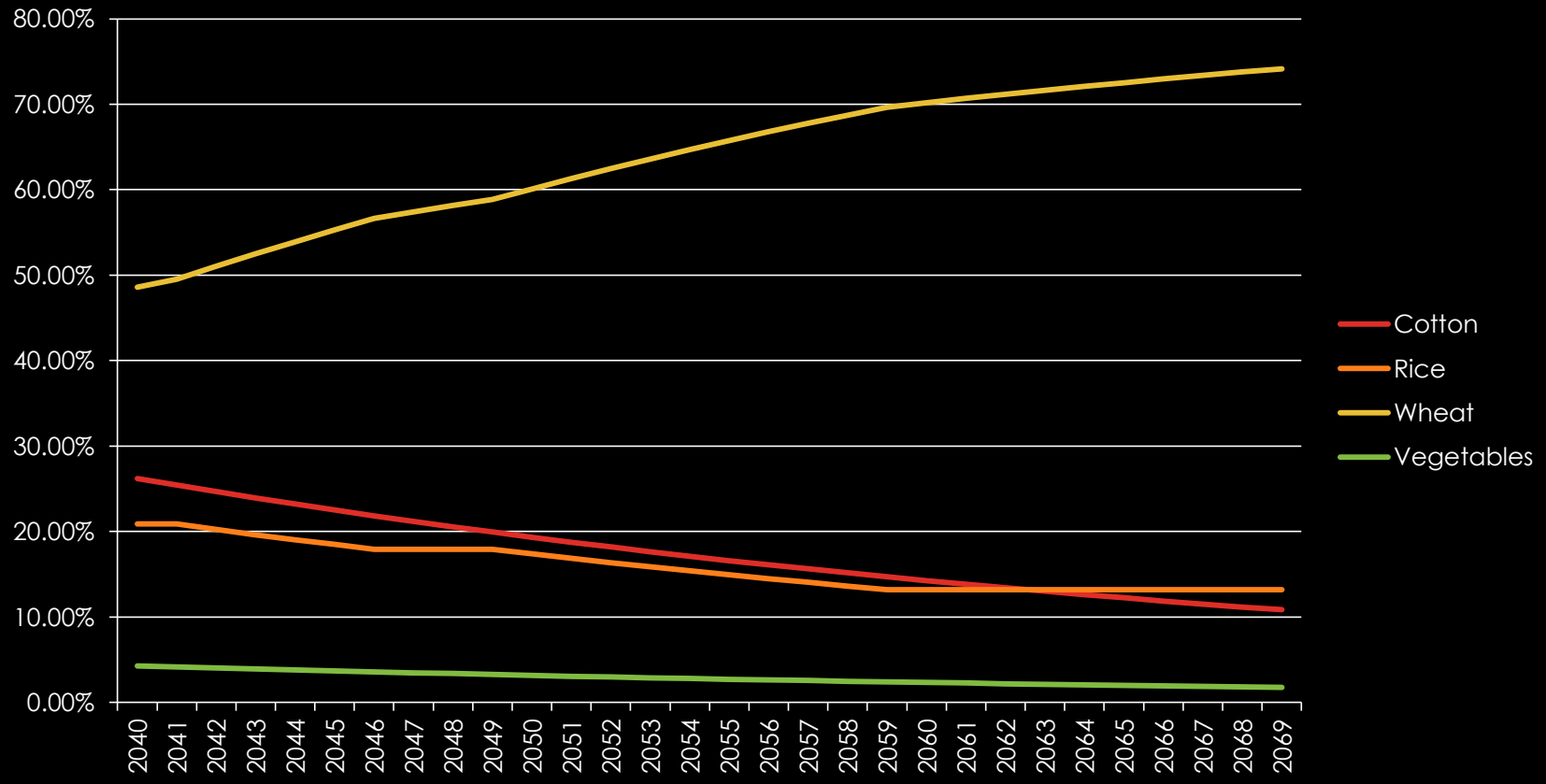
NET RETURNS COTTON QUOTA REMOVAL

	Avg Net Returns	% Change from Baseline
Near 4.5	$475.98	0.01%
Near 8.5	$513.96	0.00%
Mid 4.5	$398.00	1.43%
Mid 8.5	$428.61	1.27%
Far 4.5	$482.38	0.97%
Far 8.5	$434.68	1.52%

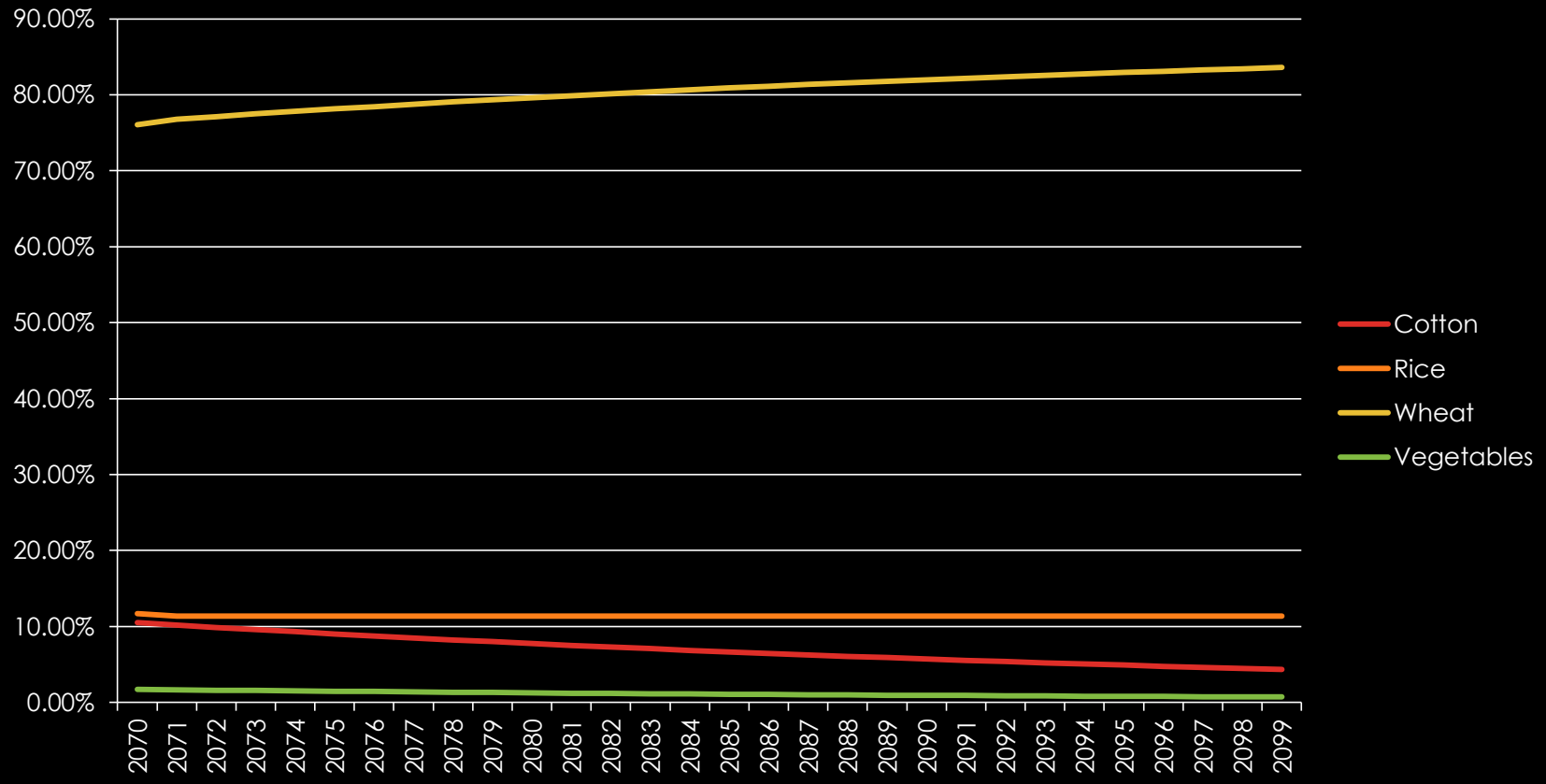
NEAR-TERM COTTON QUOTA REMOVAL



MID-TERM COTTON QUOTA REMOVAL



CENTURY COTTON QUOTA REMOVAL



CONCLUSIONS

- Climate change has a minimal impact on crop yield and producer profit
- Uzbekistan does not have comparative advantage in cotton production
- Food availability may increase as wheat production increases
- The distortions caused by lack of agricultural markets in the region make the biggest impact on agriculture

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