

# ETHANOL PRODUCTION IN INDIA: VIABILITY, CONSTRAINTS AND HIDDEN COSTS

Madhu Khanna

Kiyoshi Mino

Hayri Onal

University of Illinois, Urbana-Champaign

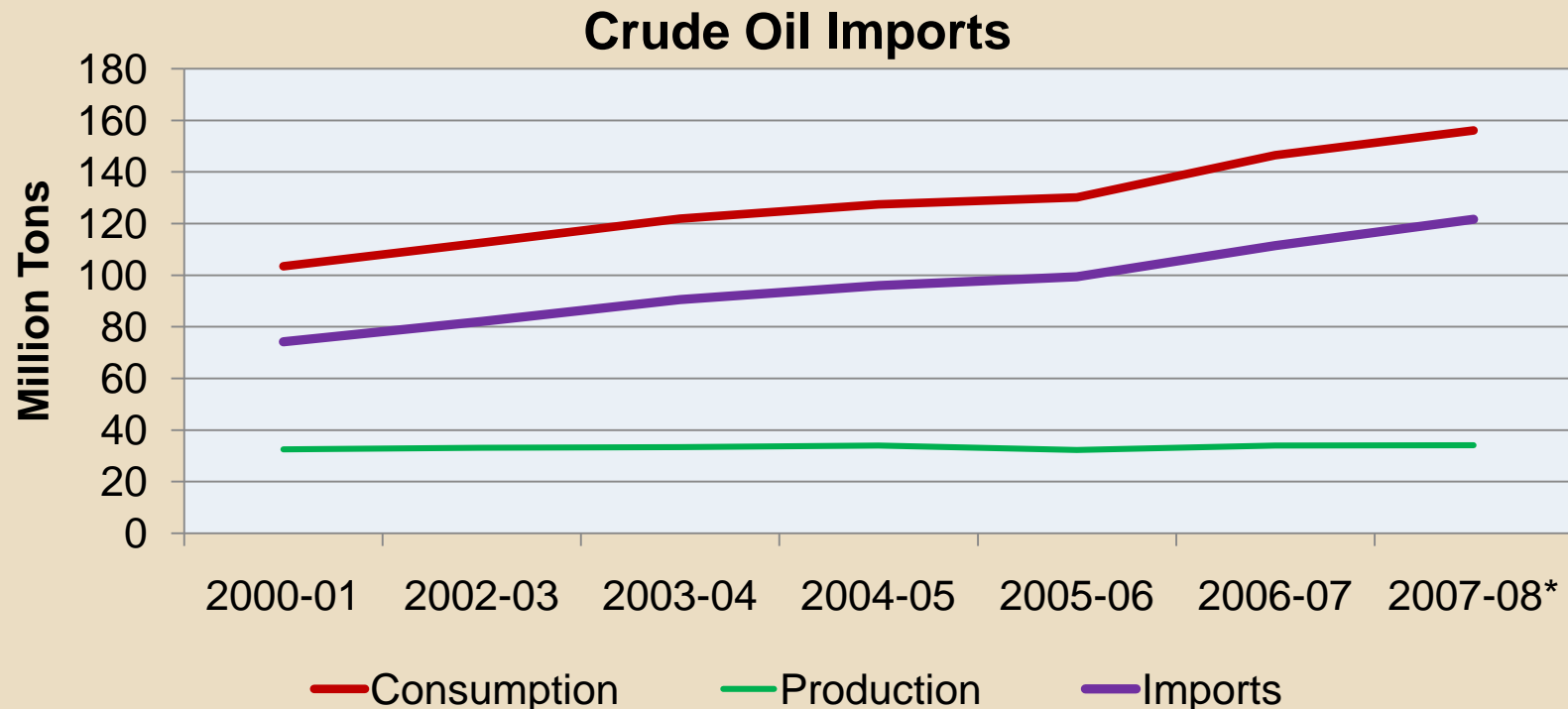
with

Ashok Gulati

IFPRI, New Delhi

# Motivations

- India imports over 70% of its crude oil.
- Has 0.4% global reserves, consumes 4% global levels
- World energy requirements 50% higher in 2030 & 45% of increase from China and India



# Other Motivations

- Address global environmental & climate change; carbon credits under CDM
- Augment employment & income in rural areas
- Meet rural energy needs
- Rehabilitate wastelands through greening



# Biofuel Policy in India

*No edible grain or edible oil to be used for bio-fuels*

## Ethanol Policy

- 2003: 1st phase ethanol program: Mandatory 5% blending in selected states
- 2007: extended to all states
- 2008: plan for mandatory 10% blending by October: Not implemented due to food security issues ( would require 0.5 B gallons ethanol)
  
- 2017: 20% blending mandate
  - ▣ Projected Gasoline Demand = 25 billion liters → Ethanol Demand = 5 billion l →
  - ▣ Molasses Demand = 22 million tonnes or
  - ▣ Sugarcane Demand = 135 million tonnes
  - ▣ 2004-05 Molasses Production = 5.5 million tonnes
  - ▣ 2004-05 Sugarcane Production = 237 million tonnes

Government fixed minimum price of ethanol of Rs 21.50 per liter

Refinery cost of gasoline in 2004-05 Rs 14.4 per liter

Significant fuel taxes about 50% of the cost of gasoline, applies to ethanol too

# Objectives

- Examine the impacts of the ethanol blend mandate in 2017 on
  - ▣ Land use allocation between sugarcane and other crops
  - ▣ Water use and allocation among crops
  - ▣ Food prices
  - ▣ Social welfare
- Examine the hidden costs of ethanol production due to input subsidies and output pricing distortions

# Research Approach

- Develop spatial multi-market model for India in 2017
  - Agricultural Commodities
    - Sugar
    - Alcohol
    - Fuel
- 14 states in India
- 3 crops
  - Sugarcane
  - Rice
  - Wheat

# Model

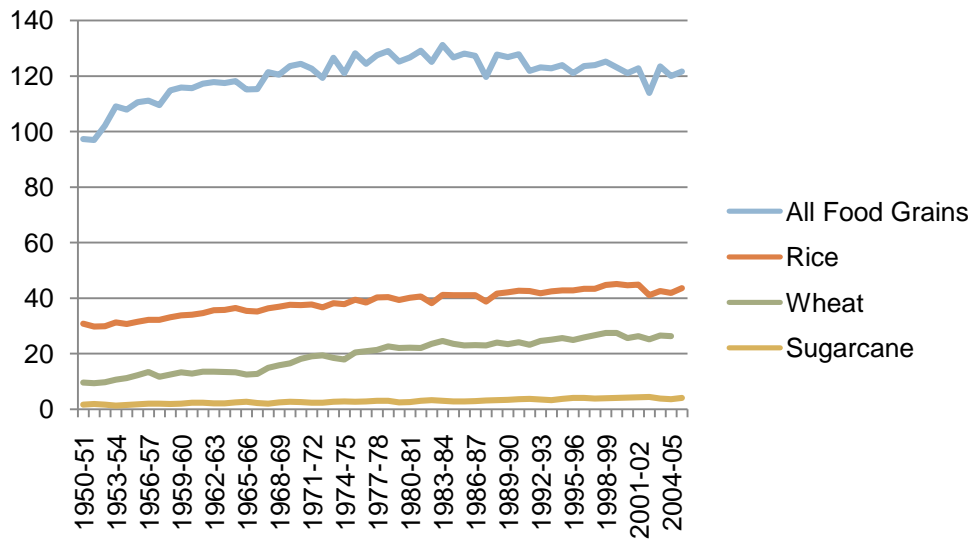
## Objective Function:

- ❑ Maximize for crop, sugar and alcohol markets:
  - ❑ Sum of domestic producer and consumer surplus
  - ❑ Sum of export producer surplus

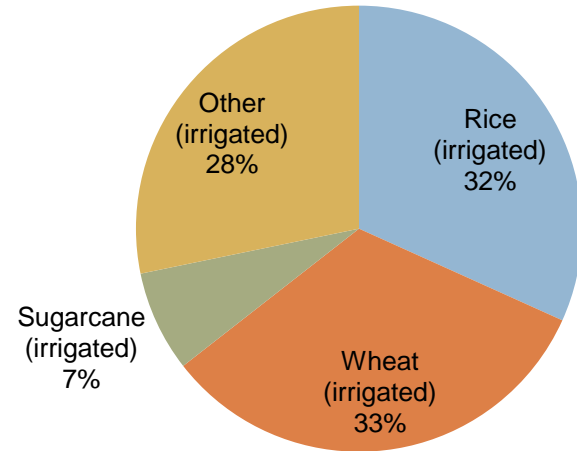
## Subject to:

- ❑ Ethanol blend mandate
- ❑ Material balance constraints
- ❑ Land constraints (irrigated and non-irrigated)
- ❑ Historical and hypothetical land use

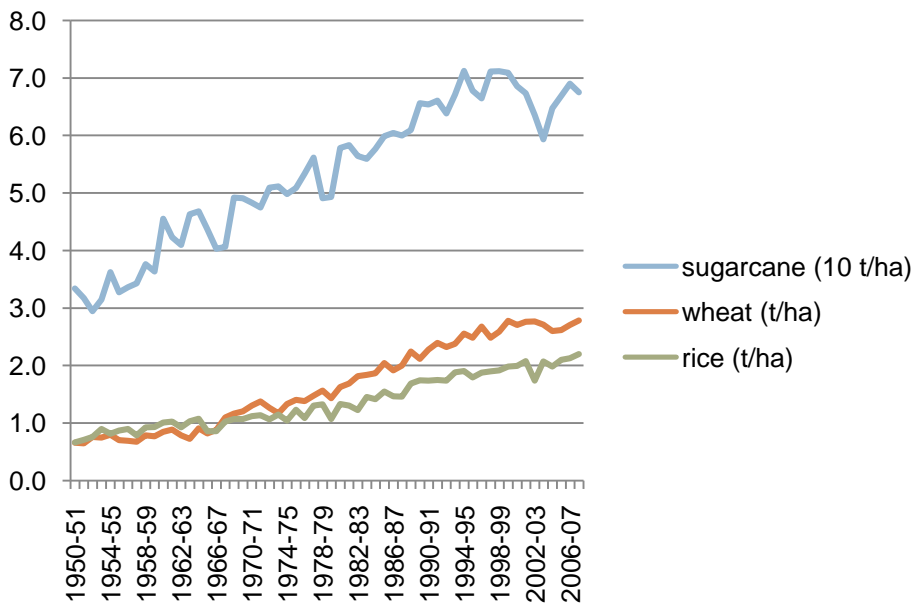
### Area Under Various Crops (M ha)



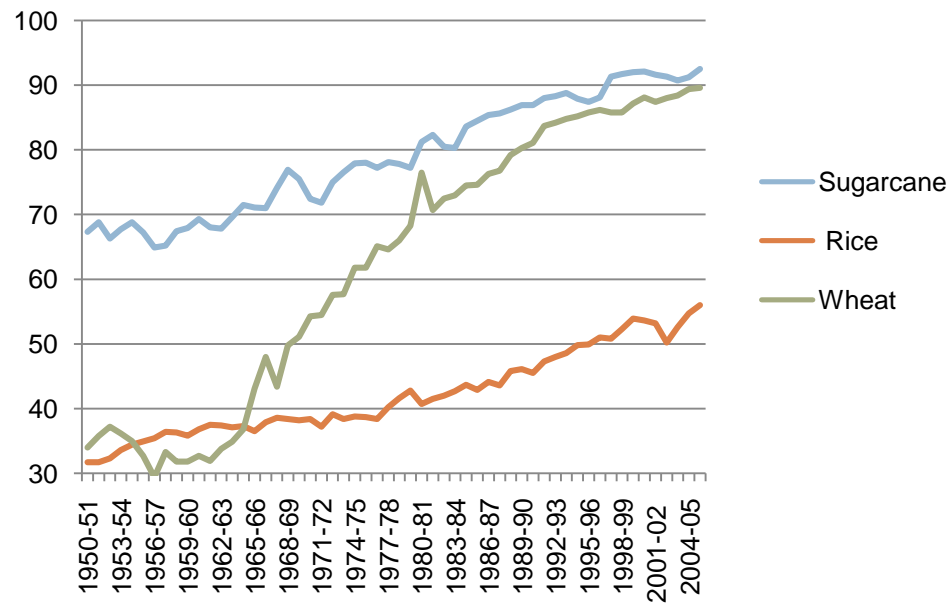
### Irrigated Land Use (2005)



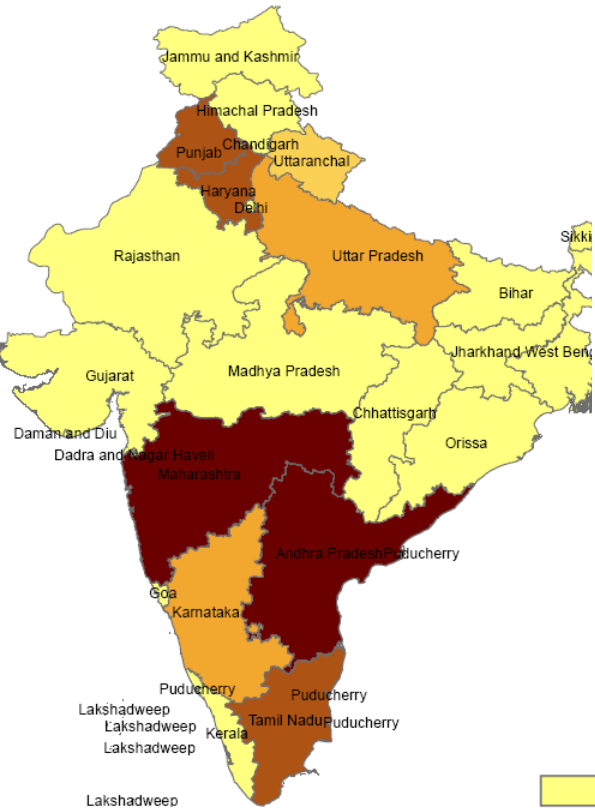
### Trends in Yields per Hectare



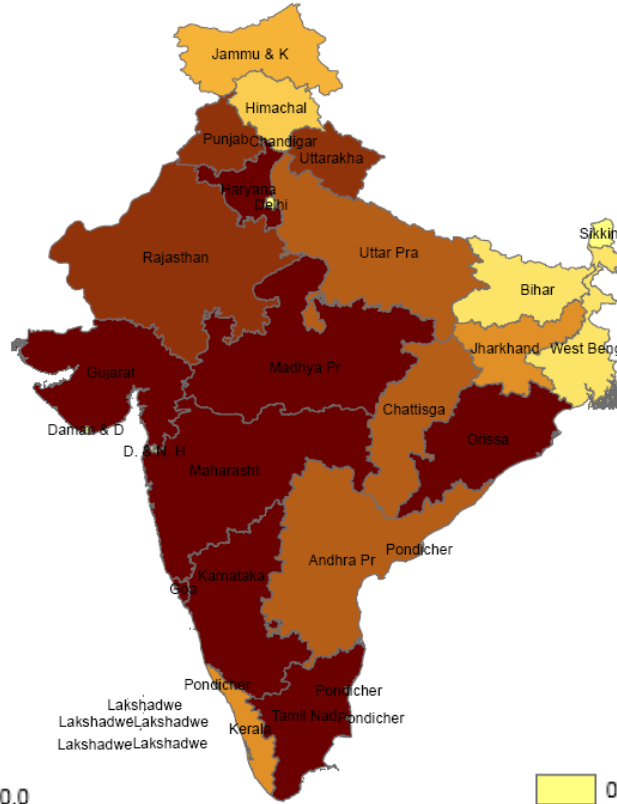
### Percentage of Irrigated Area



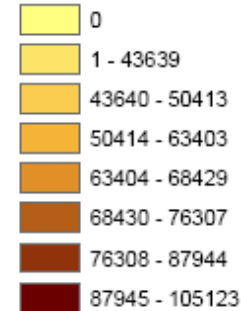
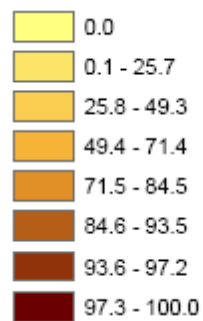
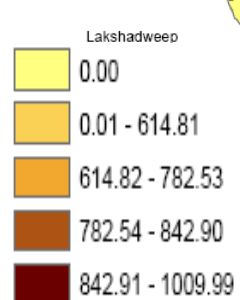
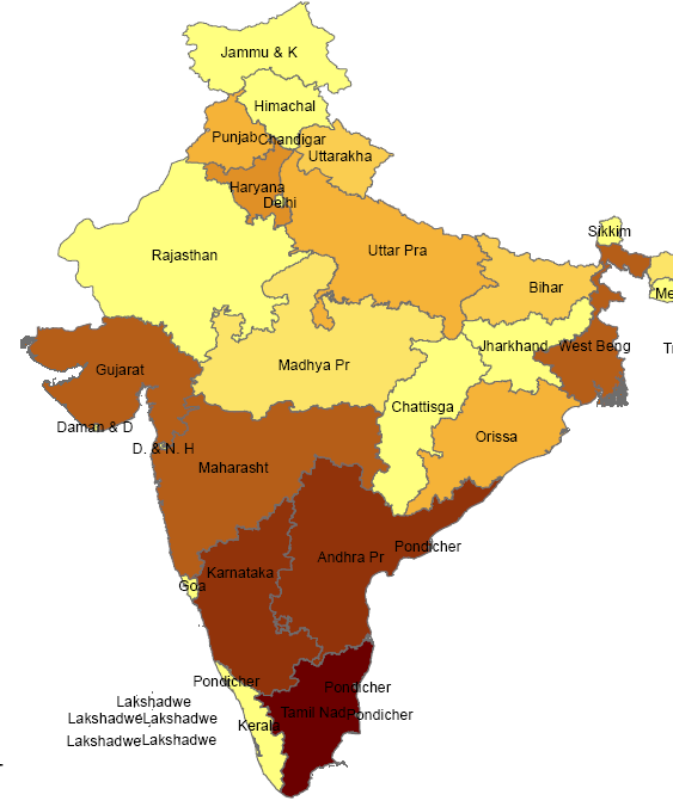
### Cost of Sugarcane production Rs/ha



### % of Sugarcane Area Irrigated

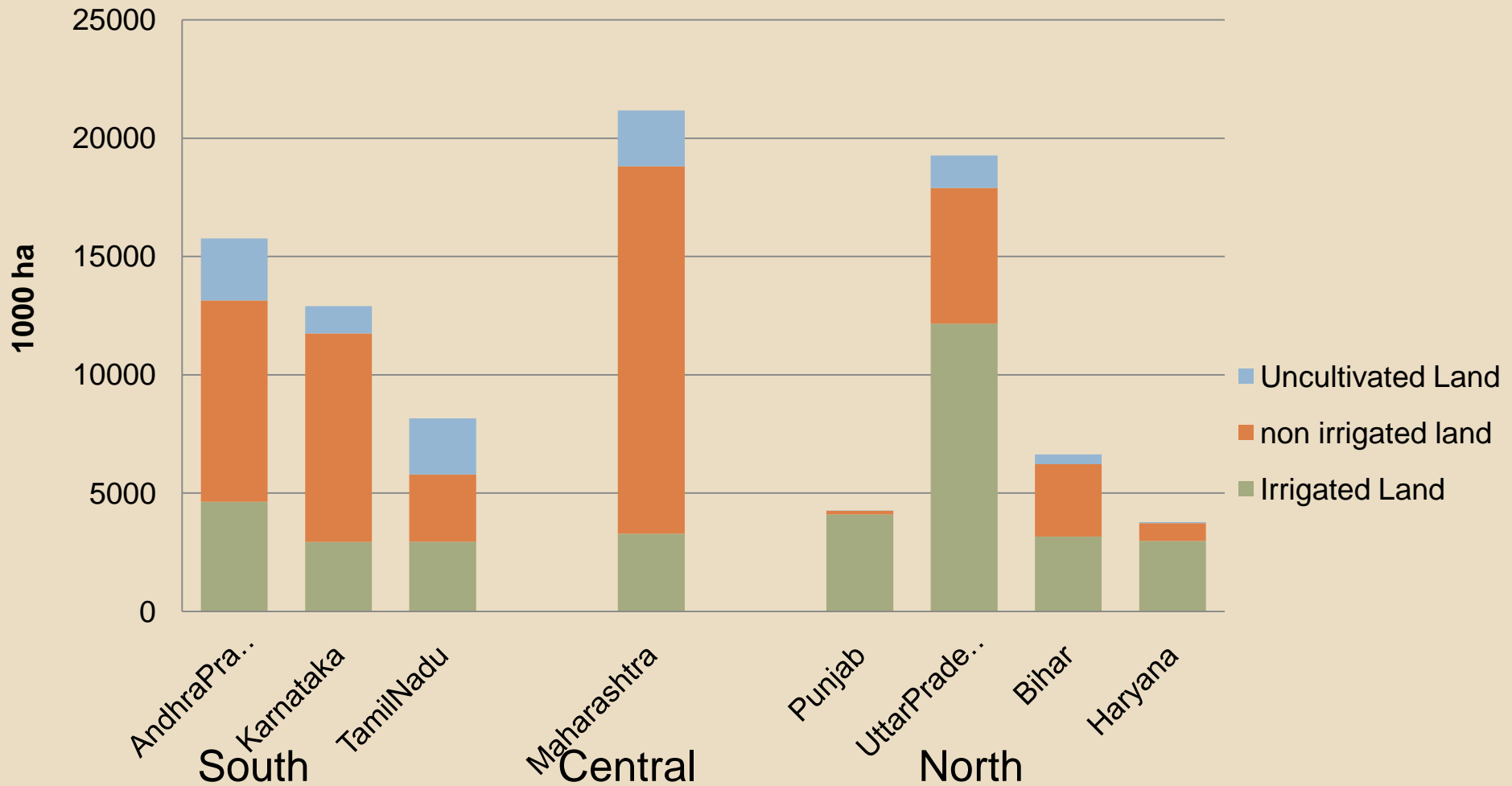


### Sugarcane Yield kg/ha



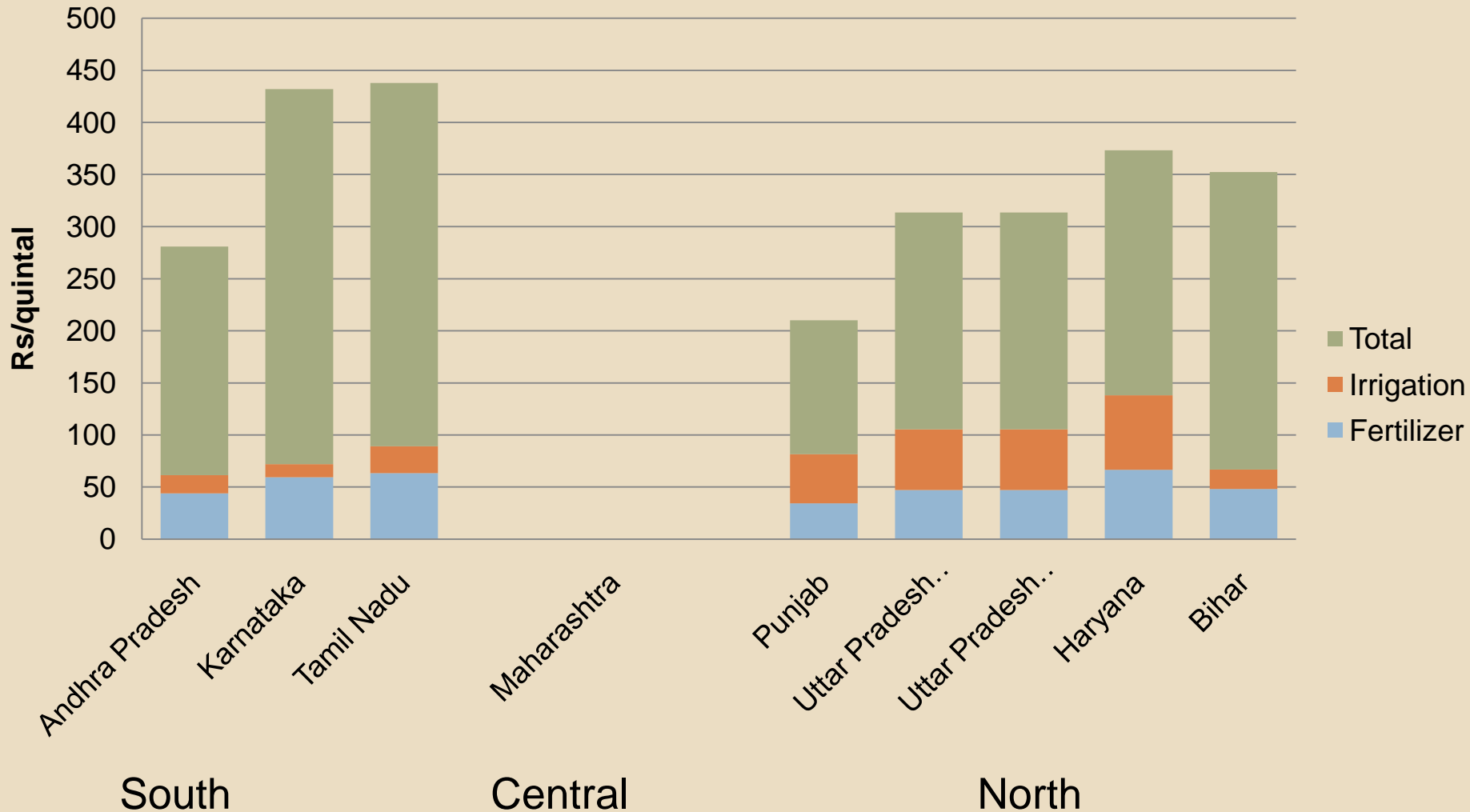
# Land and Water

## Land Availability



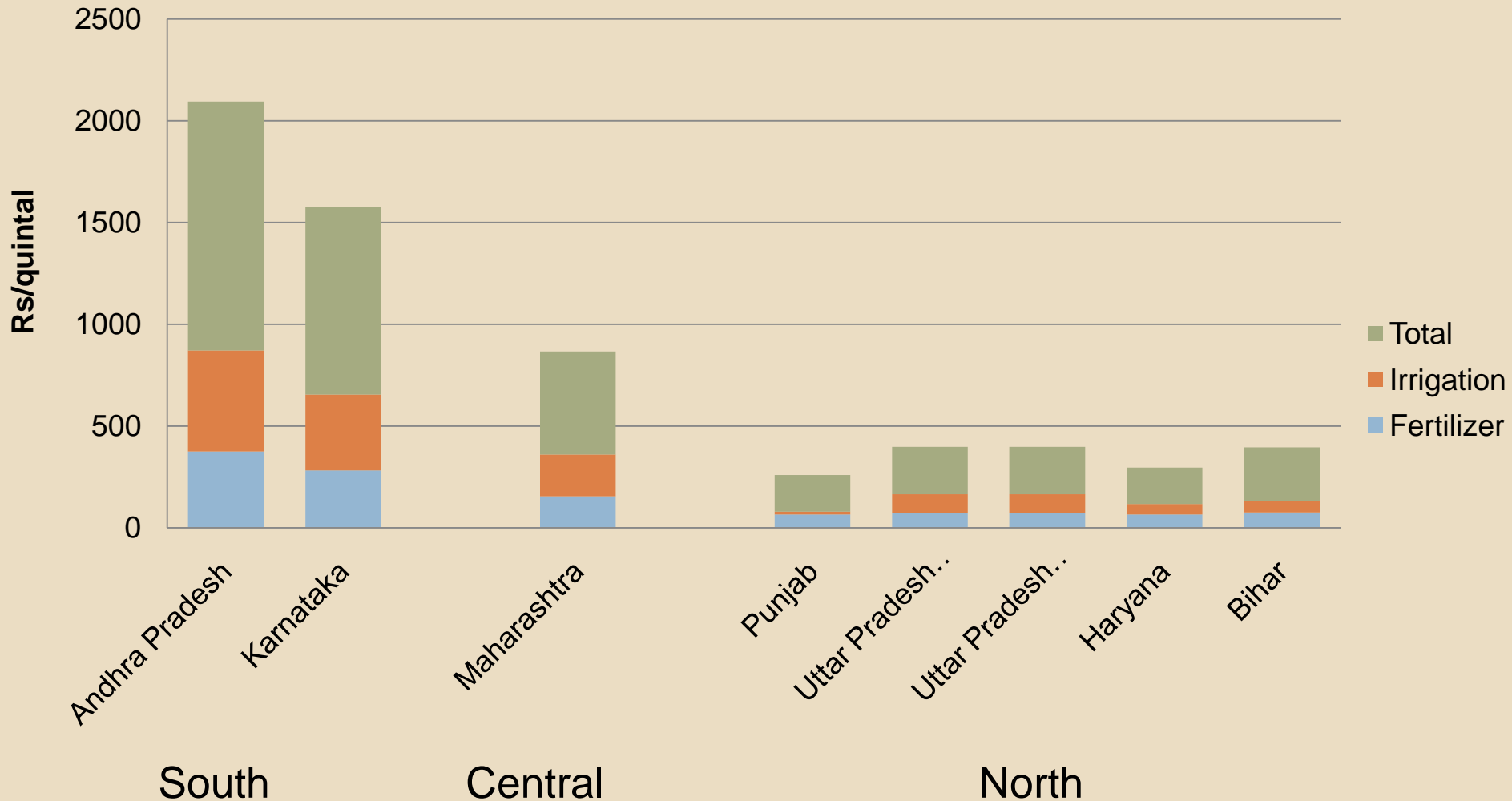
# Rice

## Irrigated Rice Costs



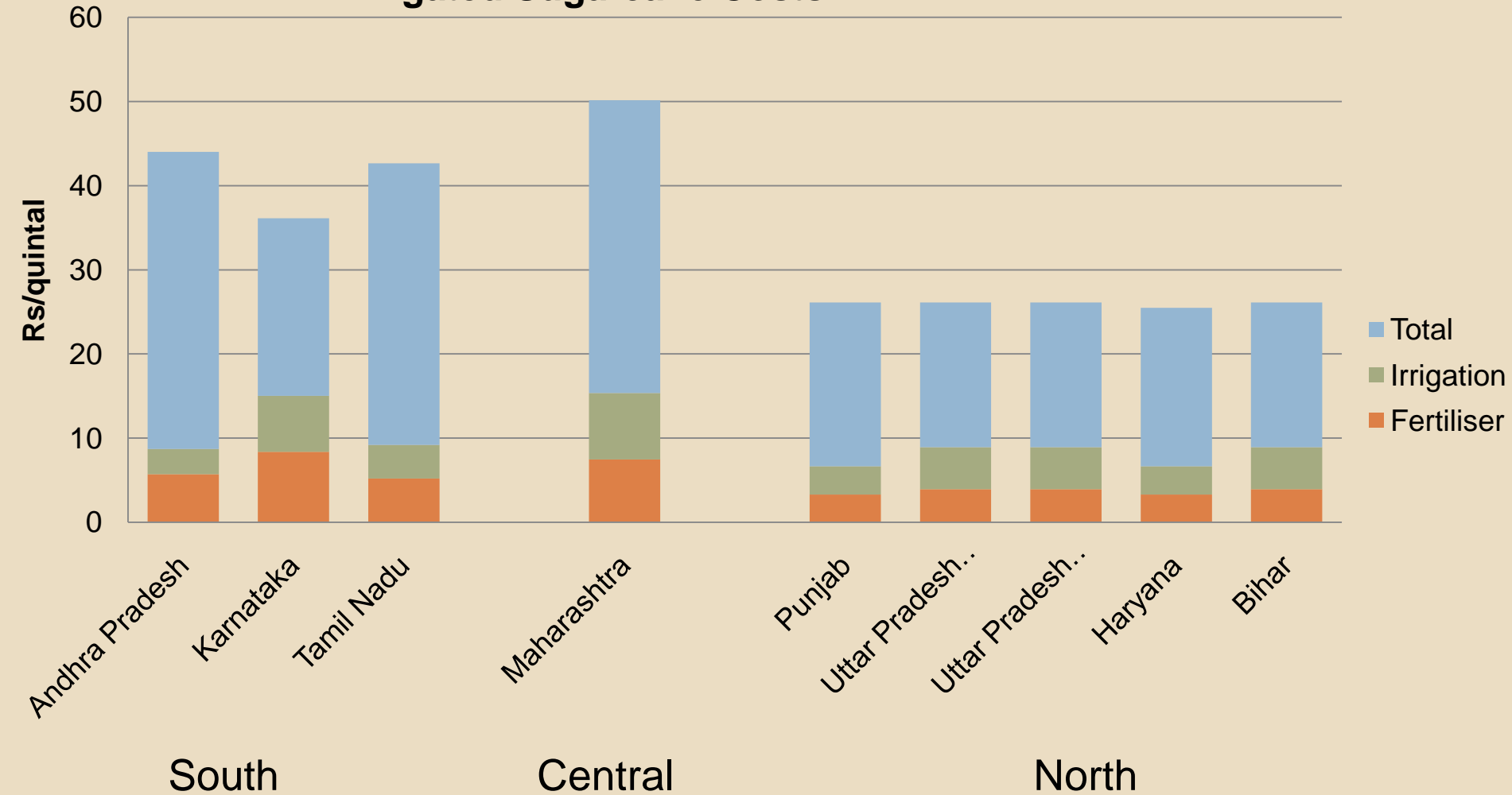
# Wheat

## Irrigated Wheat Costs



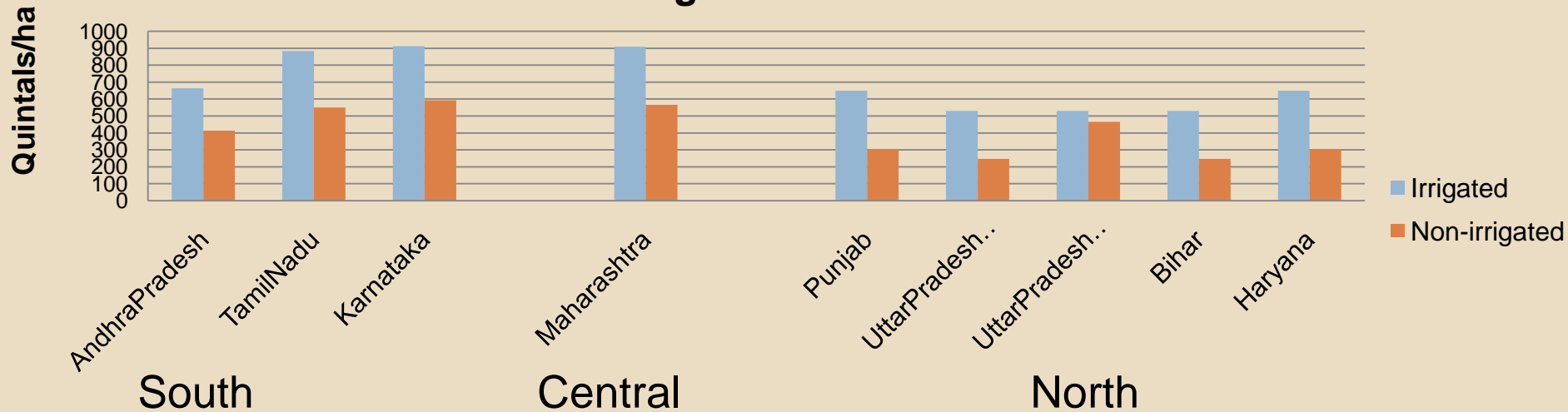
# Sugarcane

## Irrigated Sugarcane Costs

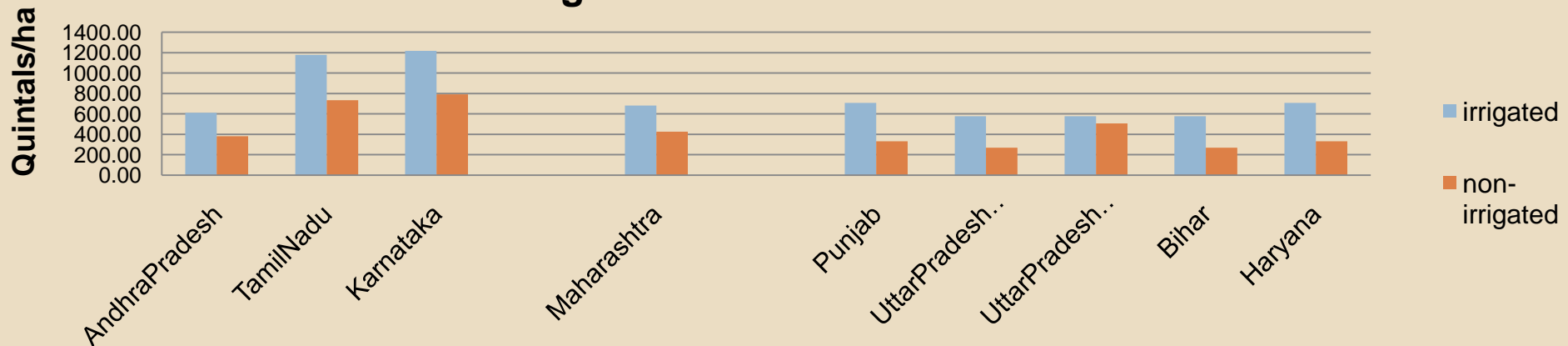


# Sugarcane Growing Seasons

## Sugarcane Yields

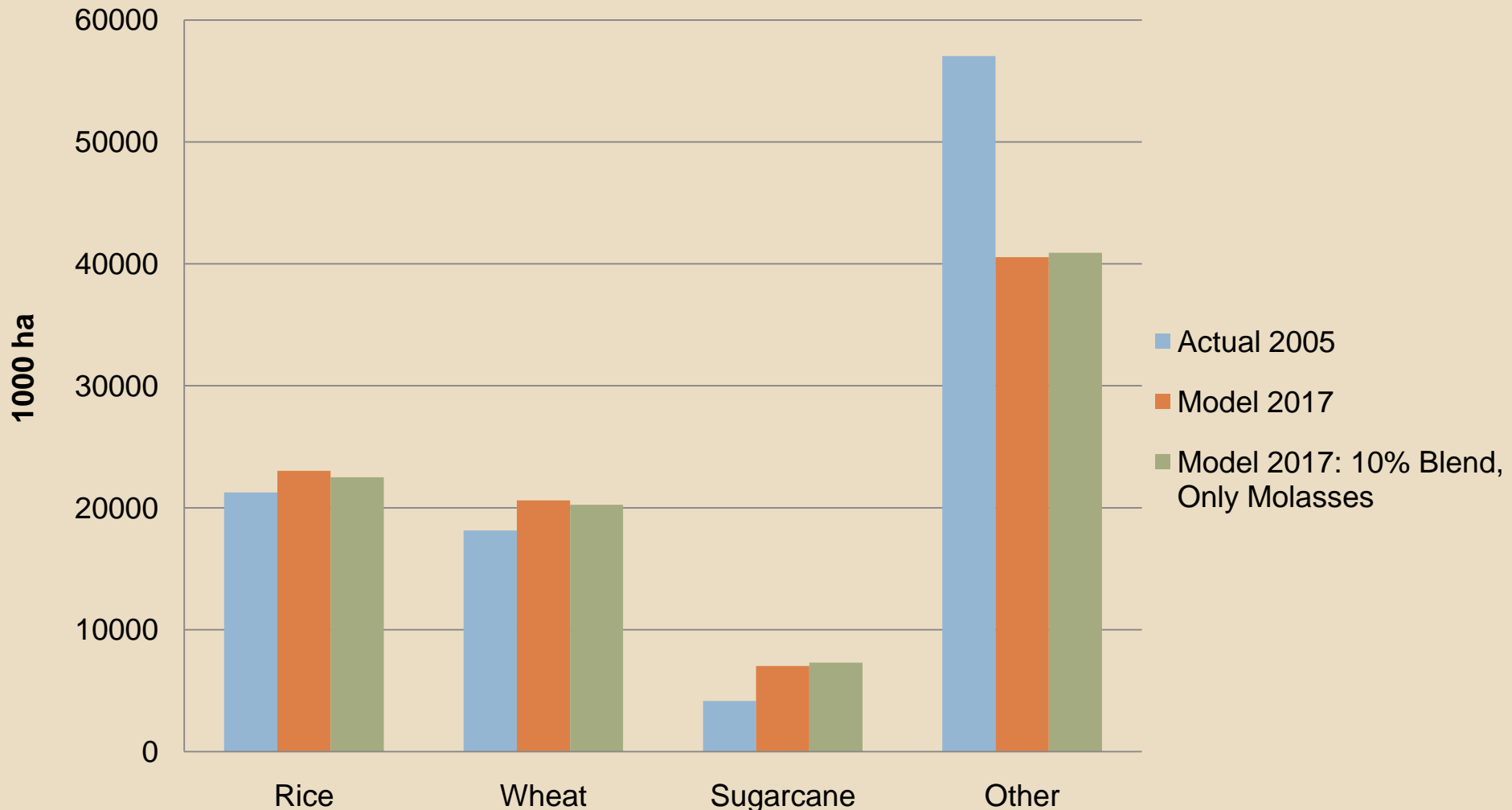


## Sugarcane Normalized Yields



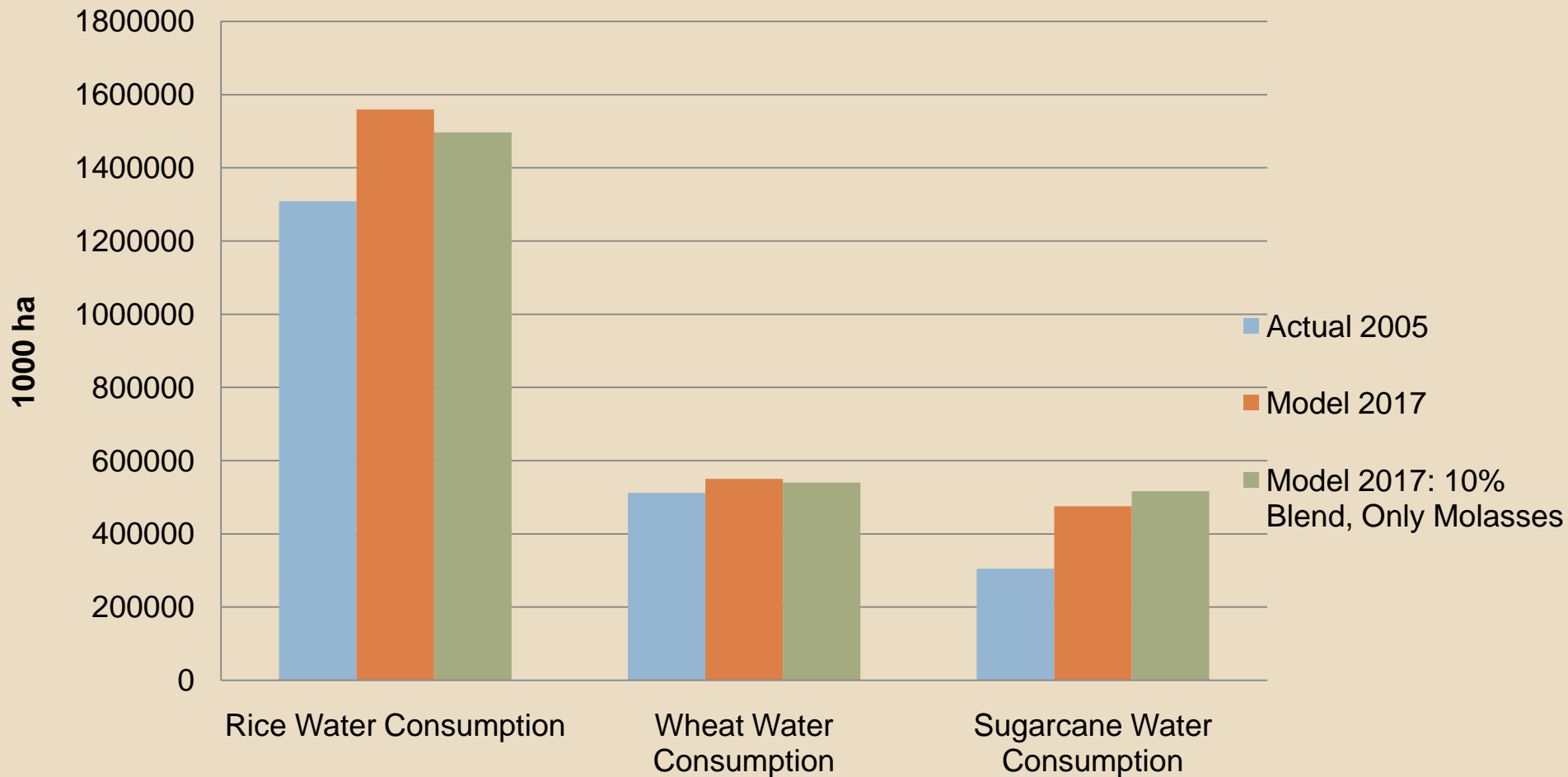
# Results: National Level

National Level: Land Use



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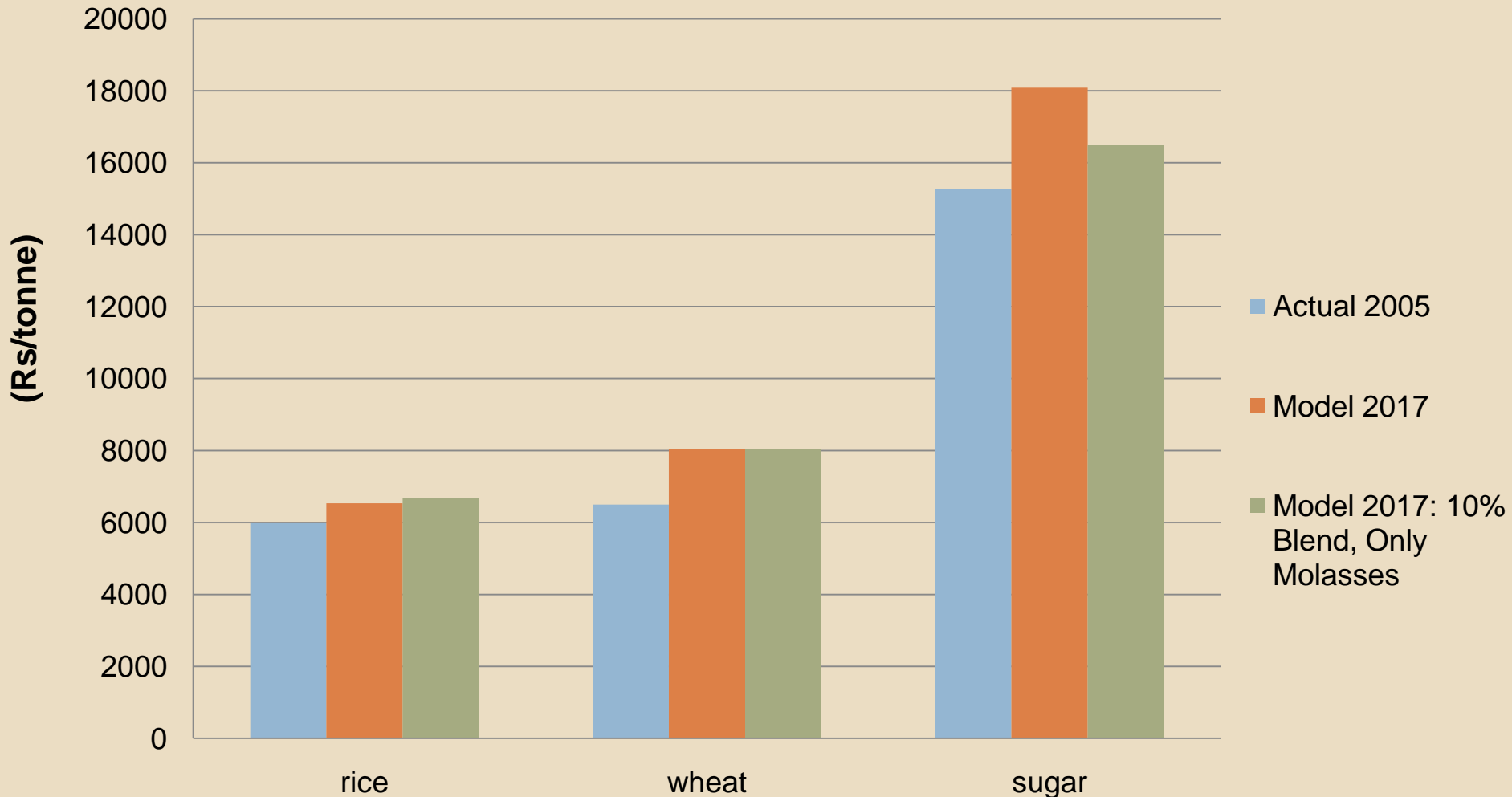
**National Level: Water Use (1000 ha cm)**



# Results: National Level



## Prices



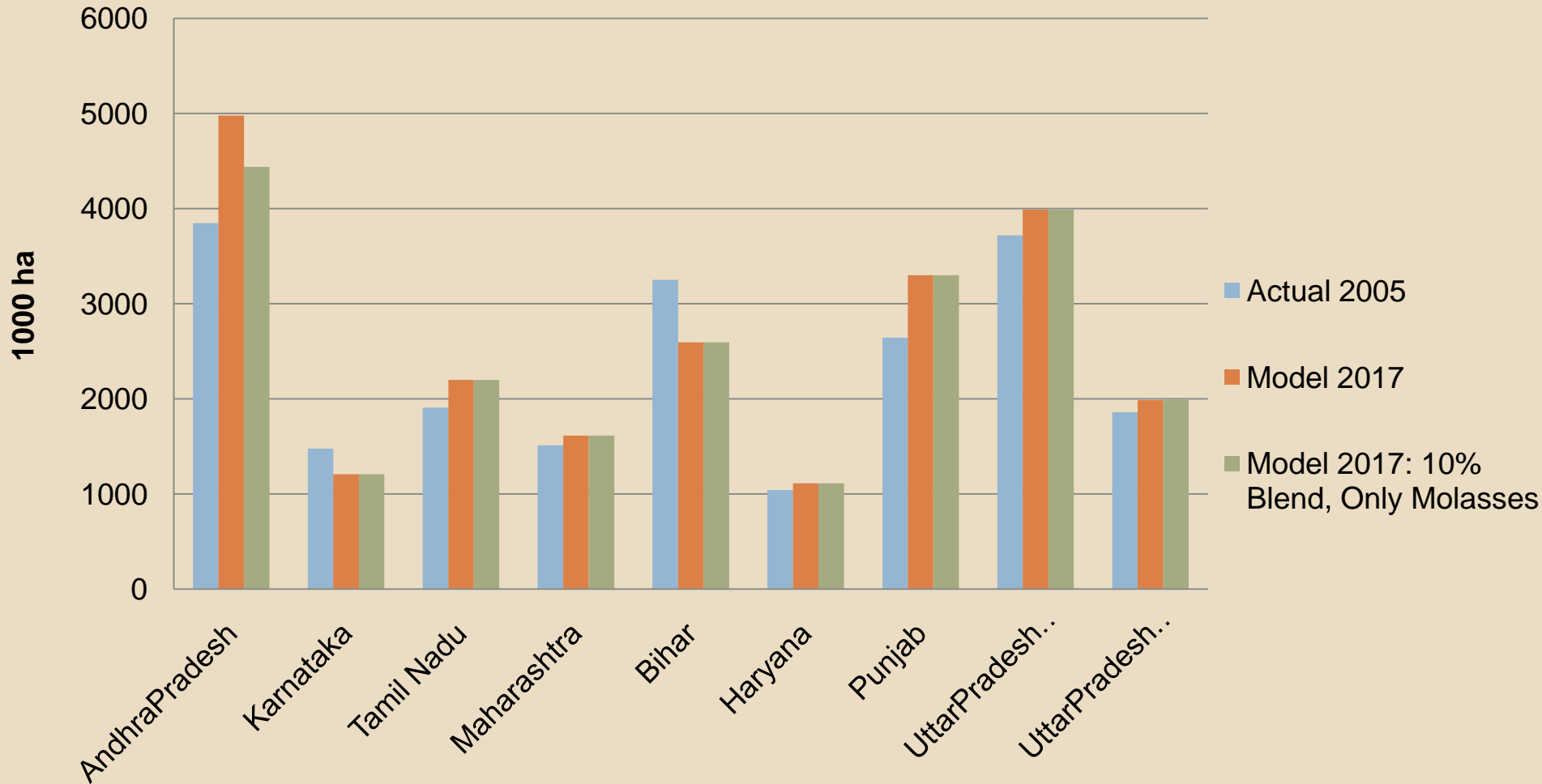
# Ethanol Production

| <b>Commodity</b>                         | <b>Actual 2005</b> | <b>Model 2017</b> | <b>Model 2017:<br/>10% Blend, Only<br/>Molasses</b> |
|------------------------------------------|--------------------|-------------------|-----------------------------------------------------|
| Alcohol<br>(billion liters)              | 1.45               | 1.00              | 1.00                                                |
| Sugarcane<br>ethanol<br>(billion liters) | 0                  | 4.97              | 2.49                                                |
| Molasses<br>ethanol<br>(billion liters)  | 0.33               | 1.96              | 2.49                                                |

# Results: State Level



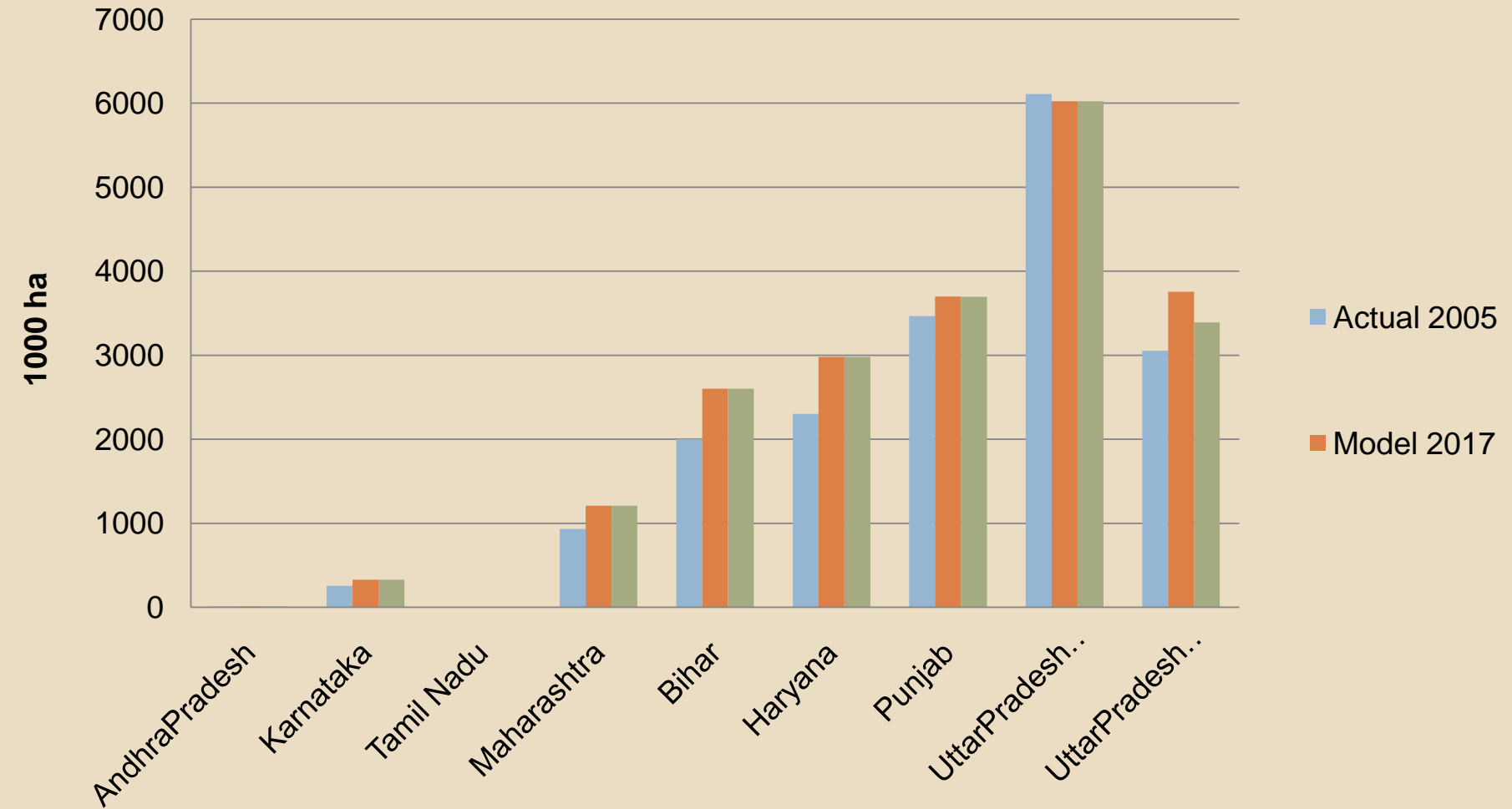
## Rice



# Results: State Level

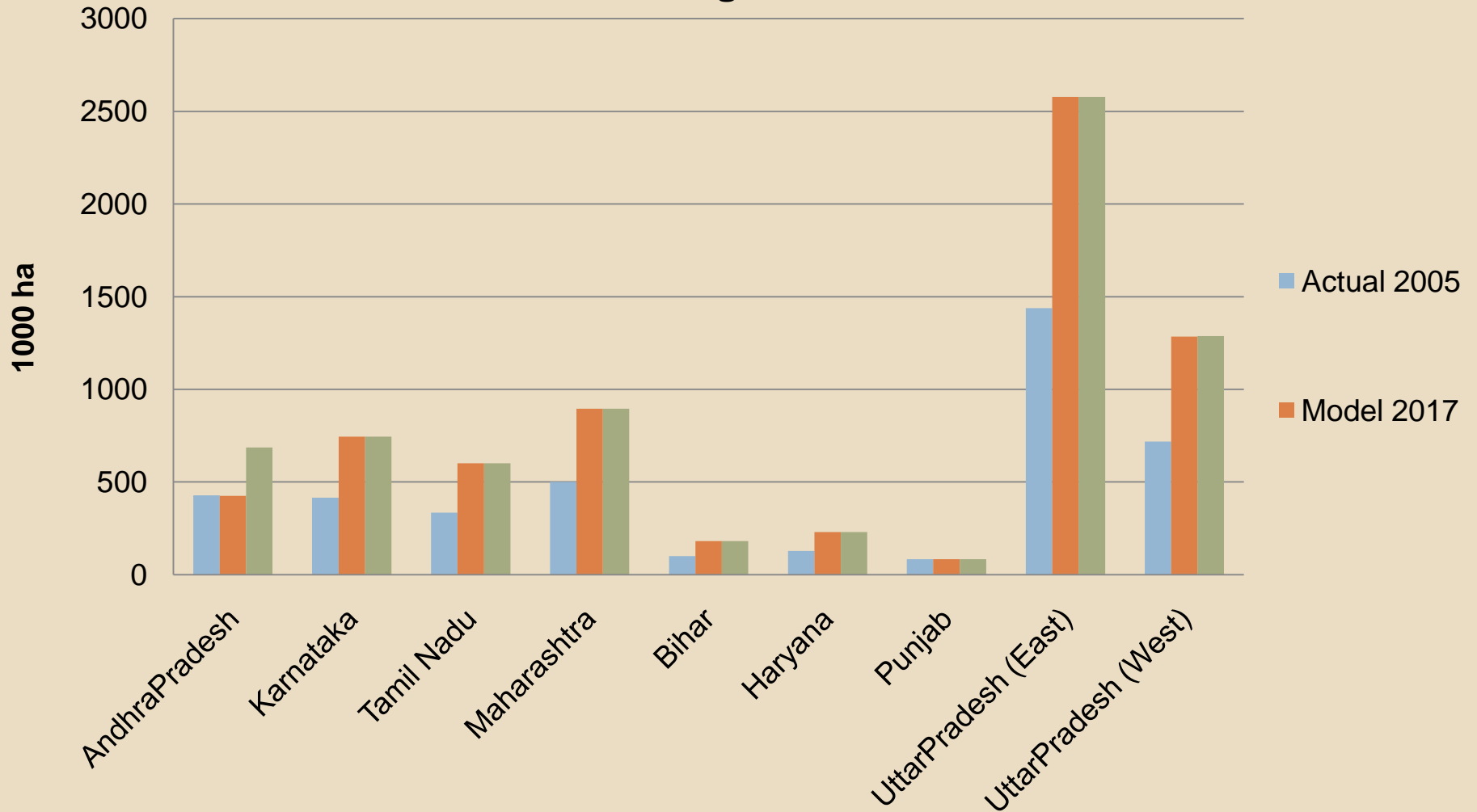


## Wheat



# Results: State Level

## Sugarcane



# Challenges for Biofuel Expansion

- Competition for land and water
- Development of infrastructure
- Institutional and policy reforms
  - Irrigation subsidies costly, leading to falling water tables
  - Deregulating sugar prices
- Need to meet growing demand and demand for changing food basket

# Concluding Remarks

- Add more states
- State level pricing for sugarcane
- Bagasse
- Acreage elasticities
- Sweet Sorghum