The Global Context for Food and Agriculture Futures in India

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The Future of Indian Agriculture: Policy Options for Competitive, Inclusive and Sustainable Growth
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Outline

- Drivers of agricultural growth and food security
- Scenario modeling methodology
- Baseline projections of supply, demand and food security
- Climate change impacts
- Alternative research investment scenario
- Conclusions and policy implications
Drivers of Agricultural Growth and Food Security
Demand and Supply Drivers

**Demand drivers**
- Population growth: 9 billion people in 2050
- Urbanization
  - World
    - 2008 = 50% urban;
    - 2050 = 78%;
  - Asia:
    - 2008 = 44%
    - 2050 = 64%
- Income growth
- Biofuels and bioenergy
- GHG mitigation and carbon sequestration

**Supply drivers**
- Water and land scarcity
- Climate change
- Investment in agricultural research
- Science and technology policy
Scenario Modeling Methodology
Climate Change Model Components

- GCM climate scenarios
  - MIROC GCM using IPCC SRES A1B scenario, downscaled temperature and rainfall

- SPAM
  - Spatial distribution of crops based on crop calendars, soil characteristics, climate of 40 most important crops

- DSSAT crop model
  - Biophysical crop response to temp and precipitation

- IMPACT modeling suite
DSSAT Crop Models

- Simulate plant growth and crop yield by variety day-by-day, in response to:
  - Temperature
  - Precipitation
  - Soil characteristics
  - Applied nitrogen
  - CO2 fertilization

- DSSAT-based simulations at crop-specific locations (using local climate, soil and topographical attributes)
The IMPACT3 Modeling Suite

Linked system of hydrological, water use, crop simulation, and partial equilibrium economic models

**IMPACT Global Hydrological Model**
- Climate Forcing
- Crop Management

**DSSAT Crop Models**
- Pop & GDP growth
- Area & yield growth

**Impact**
- Food Projections
  - Crop area / livestock numbers, yields, and production
  - Agricultural commodity demand
  - Agricultural commodity trade and prices
  - Malnourishment
  - Risk of hunger

**IMPACT Water Simulation Model**
- Irrigation Water Demand & Supply

**Water Projections**
- Water demand and supply for domestic, industrial, livestock and irrigation users
- Water supply reliability

**Effective P Potential ET IRW**

**WATER STRESS**

**Climate Forcing**
Baseline Projections of Supply, Demand and Food Security
Annual Average Growth of GDP per capita and Population between 2010 and 2050 – *Baseline Projections*

**Per Capita GDP**

- **Source:** IFPRI IMPACT Model, September 2011 simulations

**Population**

- **Source:** IFPRI IMPACT Model, September 2011 simulations
World Crop Yields
Annual Average Growth Rate, Historical and Projected

Source: IFPRI IMPACT Model, September 2011 simulations
Asia: Cereal Yield Growth

Projected Baseline Annual Average Growth Rate

Source: IFPRI IMPACT Model, September 2011 simulations
Asia: Total Cereal Crop Area

Baseline Projections

Source: IFPRI IMPACT Model, September 2011 simulations
Asia: Per Capita Demand - Baseline Projections

Cereal for Food

Source: IFPRI IMPACT Model, September 2011 simulations

Meat

Source: IFPRI IMPACT Model, September 2011 simulations
Asia: Projected Net Trade in Cereals

Baseline Projections

Source: IFPRI IMPACT Model, September 2011 simulations
Change (%) in World Prices, 2010-2050, Baseline Projections

Cereals

Source: IFPRI IMPACT Model, September 2011 simulations

Meat

Source: IFPRI IMPACT Model, September 2011 simulations
Asia: Projected Net Trade in Meat

Baseline Projections

Source: IFPRI IMPACT Model, September 2011 simulations
Asia: Population at the Risk of Hunger

Baseline Projections

Source: IFPRI IMPACT Model, September 2011 simulations
Climate Change Impacts
Rainfed Maize:
Impact of climate change in 2050

(MIROC/A1B)

Overall production change in shown existing areas: -11.2%

Source: IFPRI IMPACT simulations
Rainfed Maize: Impact of climate change in 2080

(MIROC/A1B)

Overall production change in shown existing areas: -37.3%

Source: IFPRI IMPACT simulations
Irrigated Rice: Impact of Climate Change in 2050 (MIROC/A1B)

Overall production change in shown existing areas: -10.5%

Source: IFPRI IMPACT simulations
Irrigated Rice: Impact of Climate Change in 2080 (MIROC/A1B)

Overall production change in shown existing areas: -16.1%

Source: IFPRI IMPACT simulations
Rainfed Wheat: Impact of climate change in 2050

(MIROC/A1B)

Overall production change in shown existing areas: -8.1%

Source: IFPRI IMPACT simulations
Rainfed Wheat: Impact of climate change in 2080

(MIROC/A1B)

Overall production change in shown existing areas: -15.5%

Source: IFPRI IMPACT simulations
Alternative Agricultural Investment Scenario
Increased Investment Scenario Compared to Baseline Climate Change

- Increased Investment in Agricultural R&D
  
  • Baseline assumes continuation of trend growth, 2000-2010, in CGIAR and NARS agricultural R&D
  
  • Increased investment scenario: Level of CGIAR and NARS investment in agricultural R&D is doubled by 2020 compared to the baseline, then baseline trend to 2030
Changes in World Prices of Crops Relative to Baseline, 2030 – *With increased agricultural investment*

Source: IFPRI IMPACT Model
Changes in World Prices of Meat Relative to Baseline, 2030 – With increased agricultural investment

Source: IFPRI IMPACT Model
Changes in **Cereal** Yield Relative to Baseline, 2030 – *With increased agricultural investment*

Source: IFPRI IMPACT Model
Changes in Cereal Crop Area Relative to Baseline, 2030 – With increased agricultural investment

Source: IFPRI IMPACT Model
Changes in Production of Meat Relative to Baseline, 2030 – With increased agricultural investment

Source: IFPRI IMPACT Model
Impact on Number of Malnourished Children Relative to Baseline, 2030 – *With increased agricultural investment*

- East Asia and Pacific: -18%
- Europe and Central Asia: -16%
- Latin America and Caribbean: -14%
- Middle East and North Africa: -12%
- South Asia: -10%
- Sub-Saharan Africa: -8%
- Developed: -6%
- Developing: -4%
- World: 0%
Impact on Population at Risk of Hunger Relative to Baseline, 2030 – *With increased agricultural investment*

- East Asia and Pacific: -30%
- Europe and Central Asia: -35%
- Latin America and Caribbean: -25%
- Middle East and North Africa: -30%
- South Asia: -20%
- Sub-Saharan Africa: -15%
- Developed: -5%
- Developing: 0%
- World: 0%

Source: IFPRI IMPACT Model
Conclusions and Policy Implications
Building Sustainable Productivity Growth and Resilient Agricultural and Food Systems

1. Accelerate investments in agricultural R&D for productivity growth
2. Promote complementary policies and investments
3. Reform economic policies
1. **Accelerate Investments in Agricultural R&D for smallholder productivity**

Invest in technologies for

- **Crop and livestock breeding**
  - High-yielding varieties
  - Biotic- and abiotic-stress resistant varieties
- **Modernize breeding programs in developing countries through provision of genomics, high throughput gene-sequencing, bioinformatics and computer tools**
- **GMOs where genetic variation does not exist in the crop**
  - Nitrogen use efficiency
  - Drought, heat and salinity tolerance
  - Insect and disease resistance

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**Global public spending on agric. R&D, 2008 (%)**

Source: ASTI 2012
2. Promote Complementary Policies and Investments

- Invest in rural infrastructure and irrigation
- Increase access to high-value supply chains and markets e.g. fruits, vegetables, and milk
- Regulatory reform: Reduce hurdles to approval and release of new cultivars and technologies
  - Remove impediments (e.g. restrictive “notified” crop lists, excessive testing and certification requirements, foreign investment barriers, ad hoc biosafety decision-making)
- Extension of farming systems: minimum tillage, integrated soil fertility management, integrated pest management, precision agriculture
3. Reform Economic Policies

- Support open trading regimes to share climate risk
- Use market-based approaches to manage water and environmental services combined with secure property rights
- Reduce subsidies that distort production decisions and encourage water use beyond economically appropriate levels
  - Fertilizer, energy, water subsidies
  - Savings invested in activities that boost farm output and income