Adopting Appropriate Future Climate Change Adaptation Strategies for the Thai Agricultural Sector

National Workshop

Part 2: Research Findings

Bangkok, 27 November, 2012

Contents

- Introduction to the Project
- Economywide Impacts of Climate Change
- Impacts on Agricultural Activities
- Survey of Policy Options

Introduction to the Project

1. Policy Workshop – stakeholder consultation to inform Thailand's adaptation agenda | July, 2011
2. Data and Methods Development – data compilation and synthesis, technical development of climate risk assessment tools | May-September, 2011
3. Technical Workshop – training of technical professional staff from interested ministries, academic, and independent research institutions | September, 2011
4. Collaborative Research – a sample set of policy research studies on leading climate risk challenges facing Thai agriculture | October, 2011 – October, 2012
5. Capstone Workshop | November, 2012
6. Dissemination

Research Objectives

1. Develop evidence on the economic costs of climate change and cost-benefit of adaptation
2. Improve visibility for policy makers about emergent climate risks for Thai agriculture
3. Develop policy options for effective and inclusive climate adaptation
4. Develop capacity for adaptation policy support within MOAC/OAE and other responsible ministries

Research Products

1. Capacity development through training and collaborative experience
2. Assembly of data resources
3. Development and implementation of new decision tools
4. Technical analysis for strategic agricultural sectors
5. Policy support through dissemination and dialog

Data Resources

Resource Inventories by province:

- Land conditions and use patterns
- Crops
- Livestock
- Water
- Fishery
- Forest cover and type

Thailand is rich in data, but synthesis is needed to realize its information potential.

Methods and tools for quantitative risk assessment

- Economywide forecasting model
  - To assess indirect effects of agriculture on the overall economy, as well as sector linkages from agriculture policy responses.
  - A new prototype was developed for Thailand
- Data-intensive statistical techniques to forecast crop yield/vulnerability

Climate risk in Thailand

- Issues we addressed:
  - Data needs
  - Decision tools
  - Rice
  - Tree crops
  - Other leading perennials and annuals
- Issues that still merit attention:
  - Fishery
  - Forestry
  - Ground and surface water
  - Subsistence sector

Economywide Impacts of Climate Change

- Climate change could significantly reduce long term growth of the Thai economy.
- With at least 4% lower potential GDP by 2050, substantial investments in adaptation can be justified.
- Economic impacts vary by source of climate risk, location, and activity, with the poor being more adversely affected.

Thailand InteGrated Economy and Resource (TIGER) Model

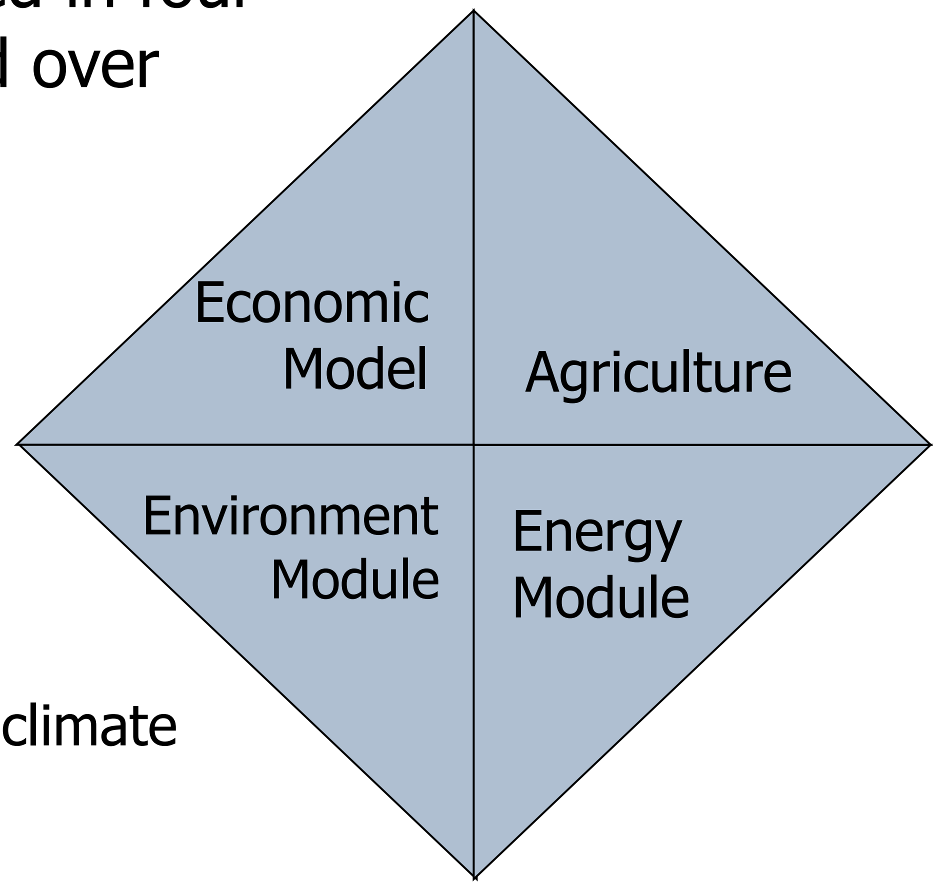
- Scenario work on long term agrifood and energy trends
  - Demand and policy scenarios – food and energy security
  - Price trend impacts with emergent technologies
  - Emergent supply-side energy trends (ag policy, biofuel, other renewables, etc.)
- Food-fuel trends and interactions
  - Integrating food and fuel capacity and demand scenarios for detailed economic impact assessment
- Geographic analysis
  - Identification of emergent demand and supply patterns
  - Integration with other GIS-based research
- Integration platform for policy dialog work
  - From qualitative to quantitative answers

How we Forecast

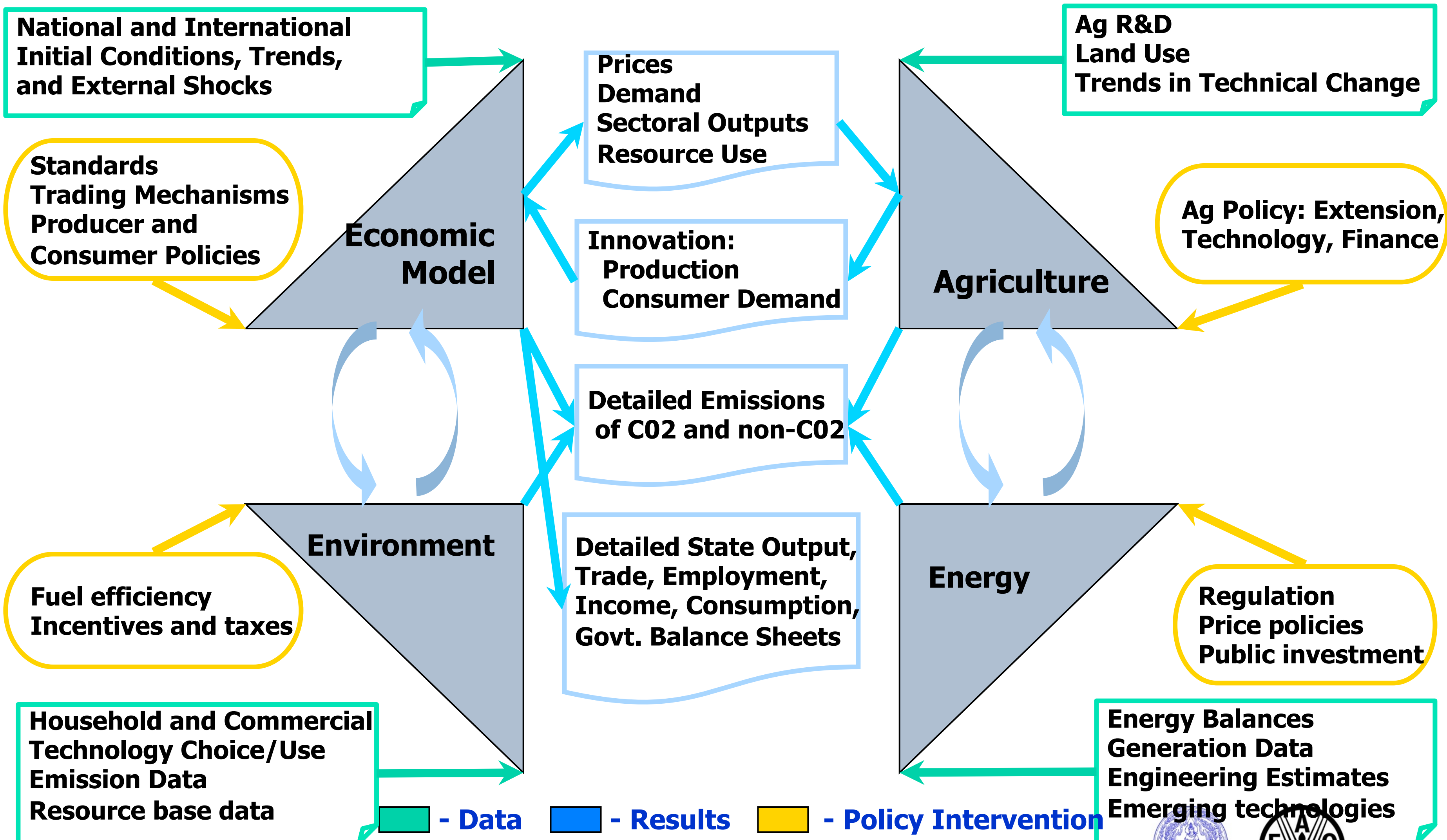
TIGER has been developed in four areas and implemented over two time horizons.

Components:

1. Core GE model
2. Agriculture Module
3. Energy Module
4. Environment/emissions/climate



Detailed Framework



Time Horizons

TIGER is used for scenario analysis over two time horizons:

1. **Policy horizon**: 2010-2030
   Detailed structural change – emphasis on energy markets, food-fuel, and policy choices to shift growth trajectories

2. **Climate horizon**: 2010-2050
   More aggregated – emphasis on technological change, climate impacts

Indicative Scenarios

Scenario	Description
Baseline	Thailand's economy grows at international (IMF/WB) consensus, Business-as-Usual rates.
Rice	Assume that, due to climate change, Thai average rice yields decline by 10% between 2012 and 2050.
Crops	Assume that average yields of all Thai field crops decline by 10% between 2012 and 2050.
Water	Assume that climate trends lead to increased economic scarcity of water, increasing its underlying resource cost 10% over 2012-2050.
Hydro	Assume water scarcity causes Thailand's electric power capacity to reach 10% below baseline growth by 2050.
Trans	Assume that storm severity intensifies, increasing trade and transport margins in the country 10% above baseline levels by 2050.

NB: Scenarios are cumulative.

Macroeconomic Impacts

Percent changes from Baseline in 2050

	Rice	Crops	Water	Hydro	Trans
Real GDP	-0.2%	-2.3%	-2.3%	-3.1%	-3.8%
HH Real Income	-0.4%	-3.3%	-3.3%	-3.6%	-4.3%
Real Consumption	-0.3%	-2.7%	-2.8%	-3.3%	-3.8%
Exports	-0.2%	-2.0%	-2.0%	-2.9%	-3.8%
Imports	-0.3%	-2.2%	-2.2%	-2.7%	-3.5%
CPI	0.5%	2.0%	2.0%	2.0%	2.4%
Real Wage	0.1%	-0.6%	-0.6%	-0.6%	-0.6%
Rental	-0.1%	-0.3%	-0.2%	-0.3%	0.1%

1. Losses not catastrophic, but large enough to justify significant adaptation investments.
2. Generally consistent with Stern, et al., but results are smaller because many climate impacts are omitted.
3. Rice impact probably underestimated because of subsistence.
4. Most serious losses from non-commodity foods and infrastructure.

Household Impacts

Percent changes from Baseline in 2050.

Income Decile	Rice	Crops	Water	Hydro	Trans
HH1	-0.6%	-4.1%	-4.2%	-4.6%	-5.0%
HH2	-0.7%	-3.9%	-4.0%	-4.6%	-5.0%
HH3	-0.7%	-3.9%	-4.0%	-4.6%	-5.0%
HH4	-0.7%	-3.9%	-4.0%	-4.5%	-4.9%
HH5	-0.6%	-3.9%	-3.9%	-4.5%	-4.9%
HH6	-0.6%	-3.8%	-3.9%	-4.4%	-4.8%
HH7	-0.6%	-3.7%	-3.7%	-4.3%	-4.8%
HH8	-0.5%	-3.5%	-3.6%	-4.1%	-4.6%
HH9	0.3%	0.3%	0.2%	-0.4%	-1.2%
HH10	-0.4%	-3.7%	-3.7%	-4.1%	-4.6%
Average	-0.3%	-2.7%	-2.8%	-3.3%	-3.8%

1. Averages mask significant differences in adjustment costs.
2. The poor bear the highest burden.

Impacts on Agriculture

- Depending on the crop, climate yield impacts can be significant in either direction.
- Spatial heterogeneity matters – around the country, impacts vary in both direction and severity.
- Most yield risks are well within historical ranges of agricultural productivity growth.

Climate Change and Crops: Critical Environmental Factors

- Temperature:
  - Anticipated changes in global climate will increase both the <u>mean</u> and <u>variance</u> of temperatures.
  - Both factors will increase plant stress and, for many important crops, reduce yields.
- Water:
  - Rainfall patterns will change significantly, with intensified seasonal scarcity and storm severity (flooding and wind damage).

Data Overview: Agricultural

- Production: Annual provincial production data includes yields, planted area, harvested area, total output (OAE).
- Growing Season: Regional planting and harvesting dates for several years, averaged to approximate long-run average growing season (OAE).
- Crop Location: GIS information on the location of planted area by crop (cite).
- Irrigation: GIS information on irrigation extent (cite).

Data Overview: Climate

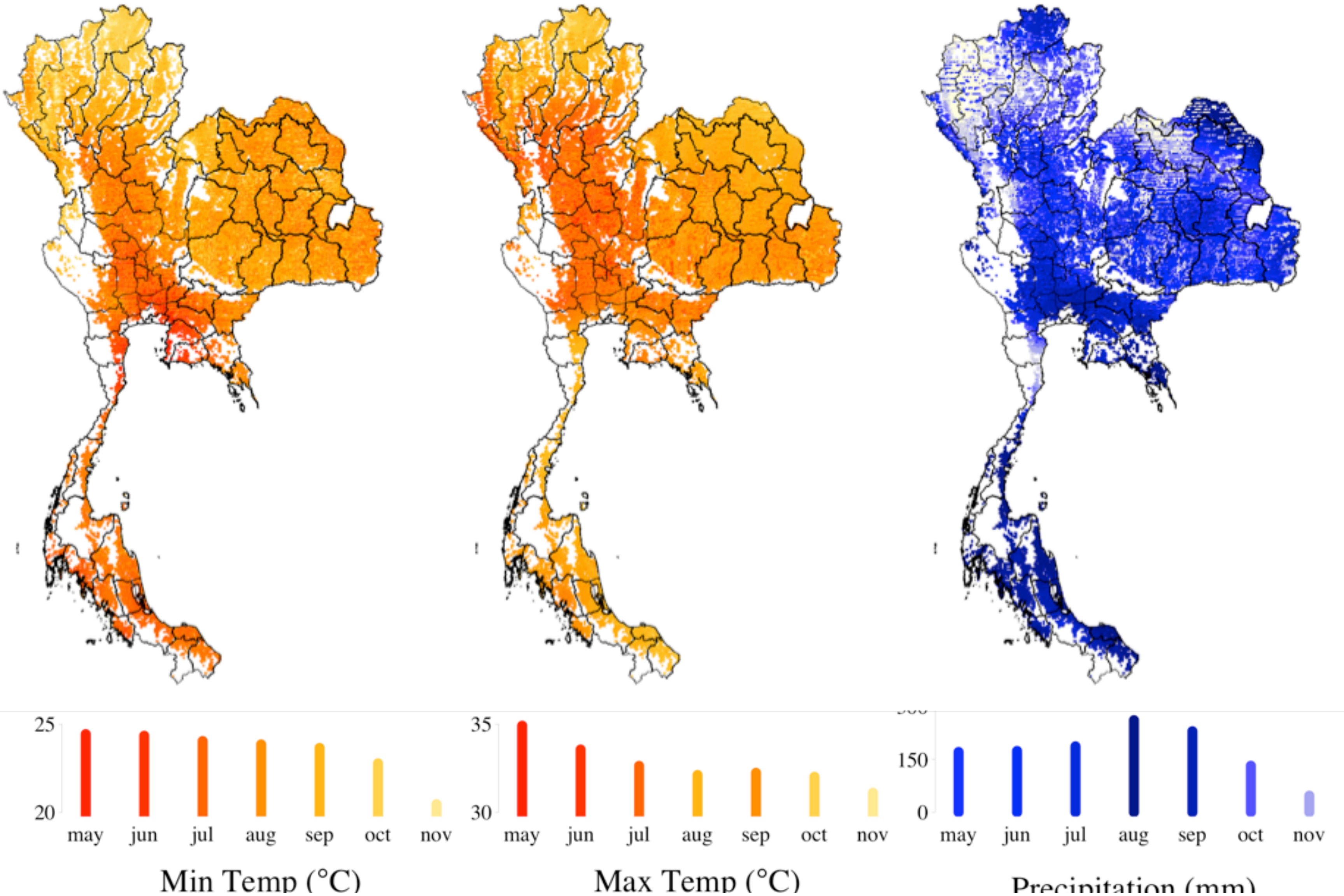
- Historical Weather: Daily weather station data are interpolated over the country in 4x4km grid cells and then averaged over crop growing areas for each year.
  - Radiation data from NASA satellites.

- Climate Change Scenarios: Outputs from 18 different GCMs under 3 different emissions scenarios (IPCC)

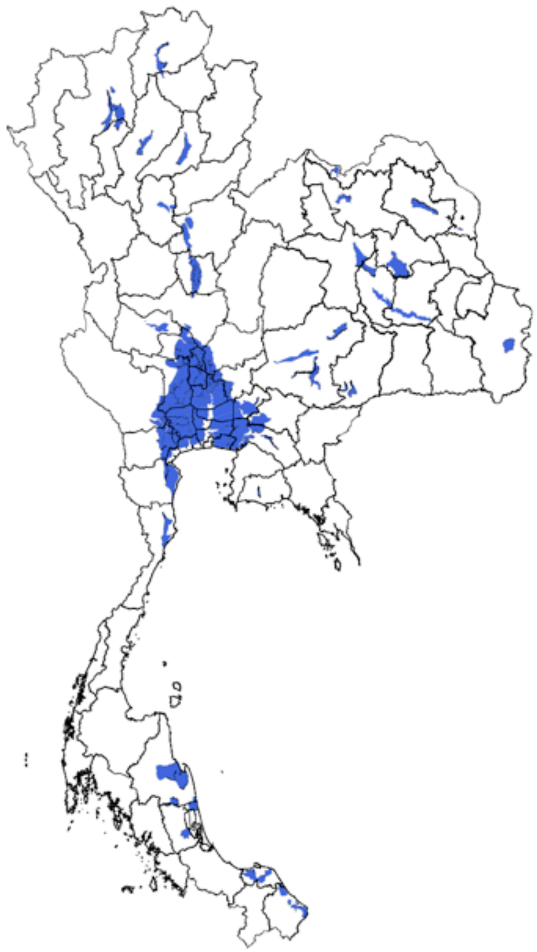
Yield Estimation Model

- Exploit year-to-year deviations in weather to measure their impacts on yields.
  - Assumes that year-to-year fluctuations in weather are random.
- Total effect is the average effect across provinces over 30 year study period.
  - Effects can be modeled linearly
    - (effect of Temp moving 24->25 = effect of moving 28->29)
  - or non-linearly
    - Estimate different relationships above and below "cutoff points" (i.e., thresholds).
    - The cutoffs that best fit the data are selected for each weather variable

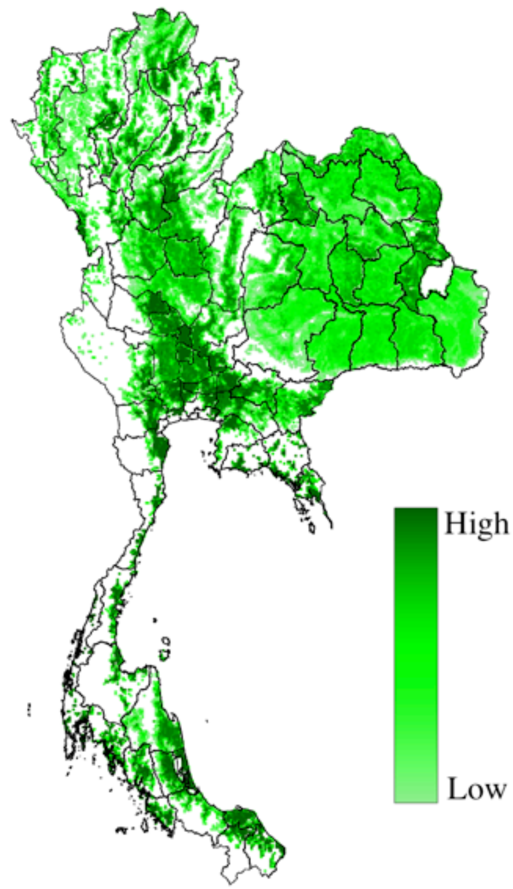
Growing Season Temperature and Rainfall



Sources of Vulnerability: Water

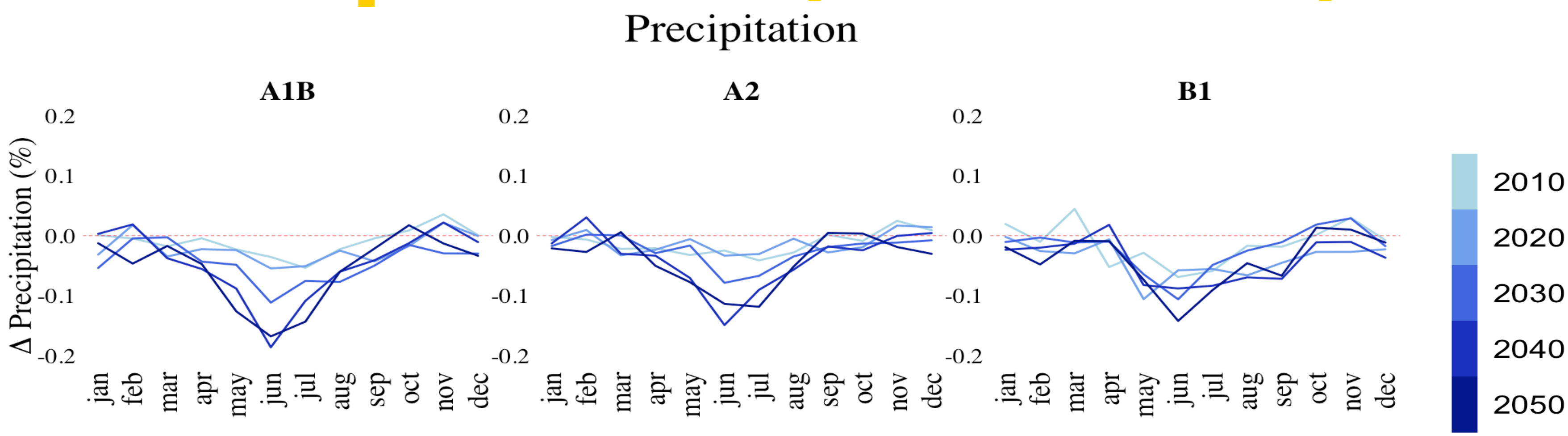


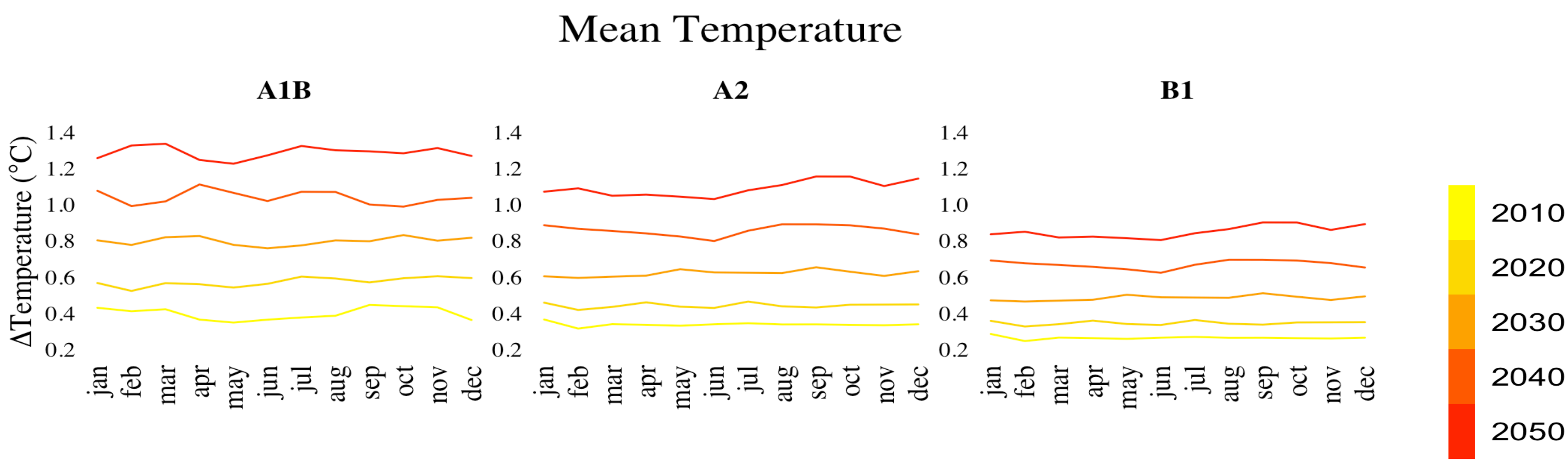
Irrigation Extent



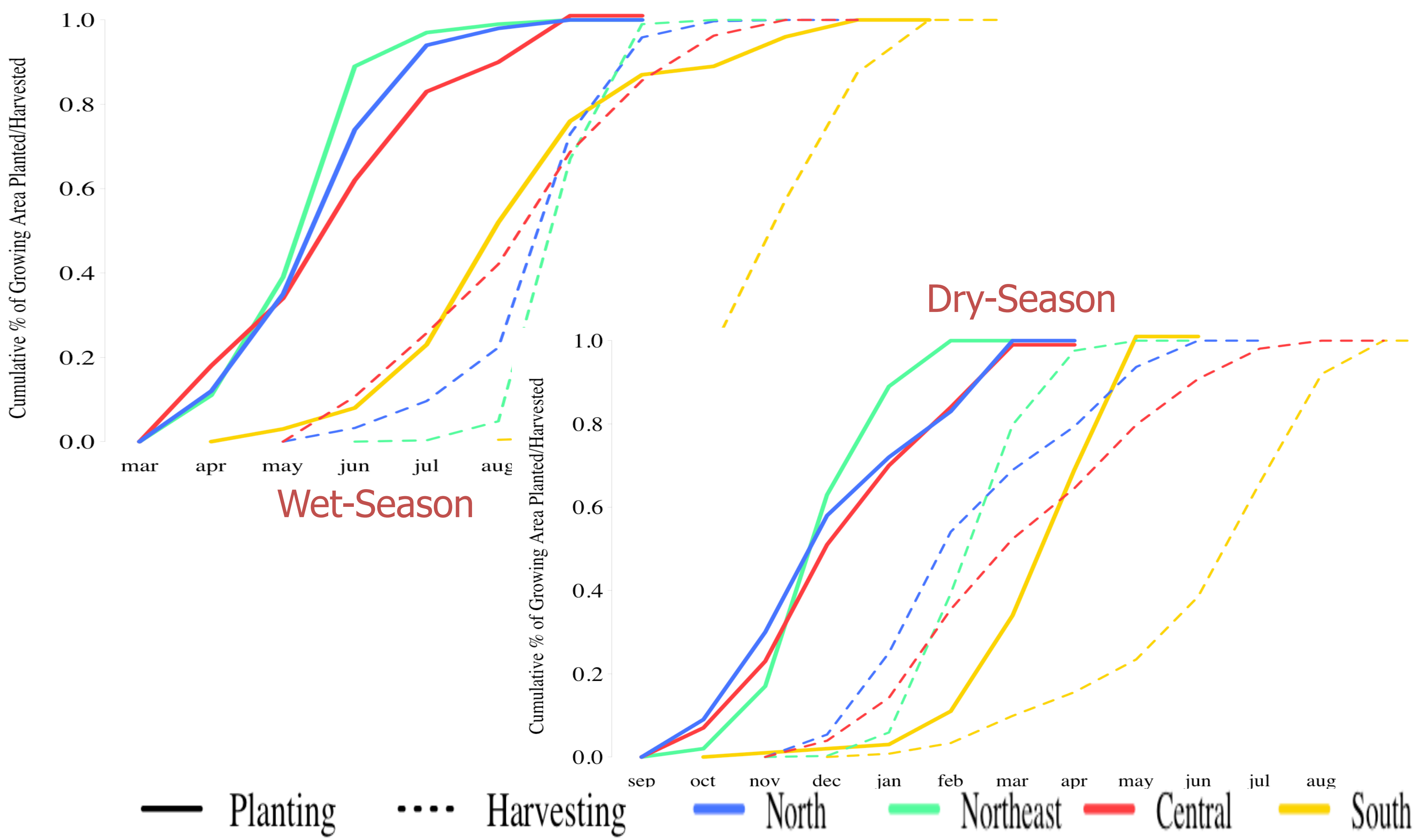
Planted Density

Monthly Changes in Precipitation and Temperature (GCM Forecasts)

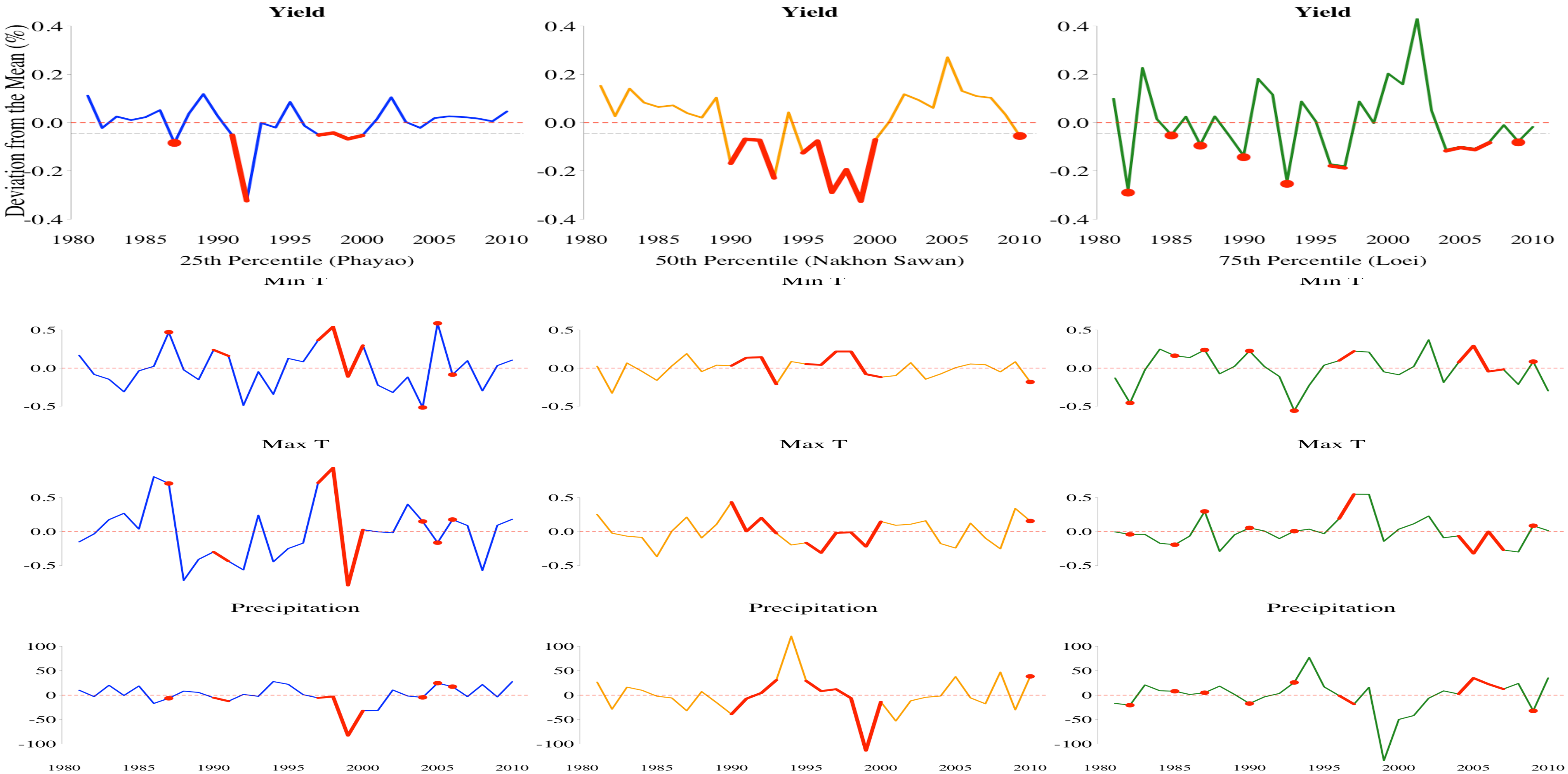




Rice: A history of adaptation



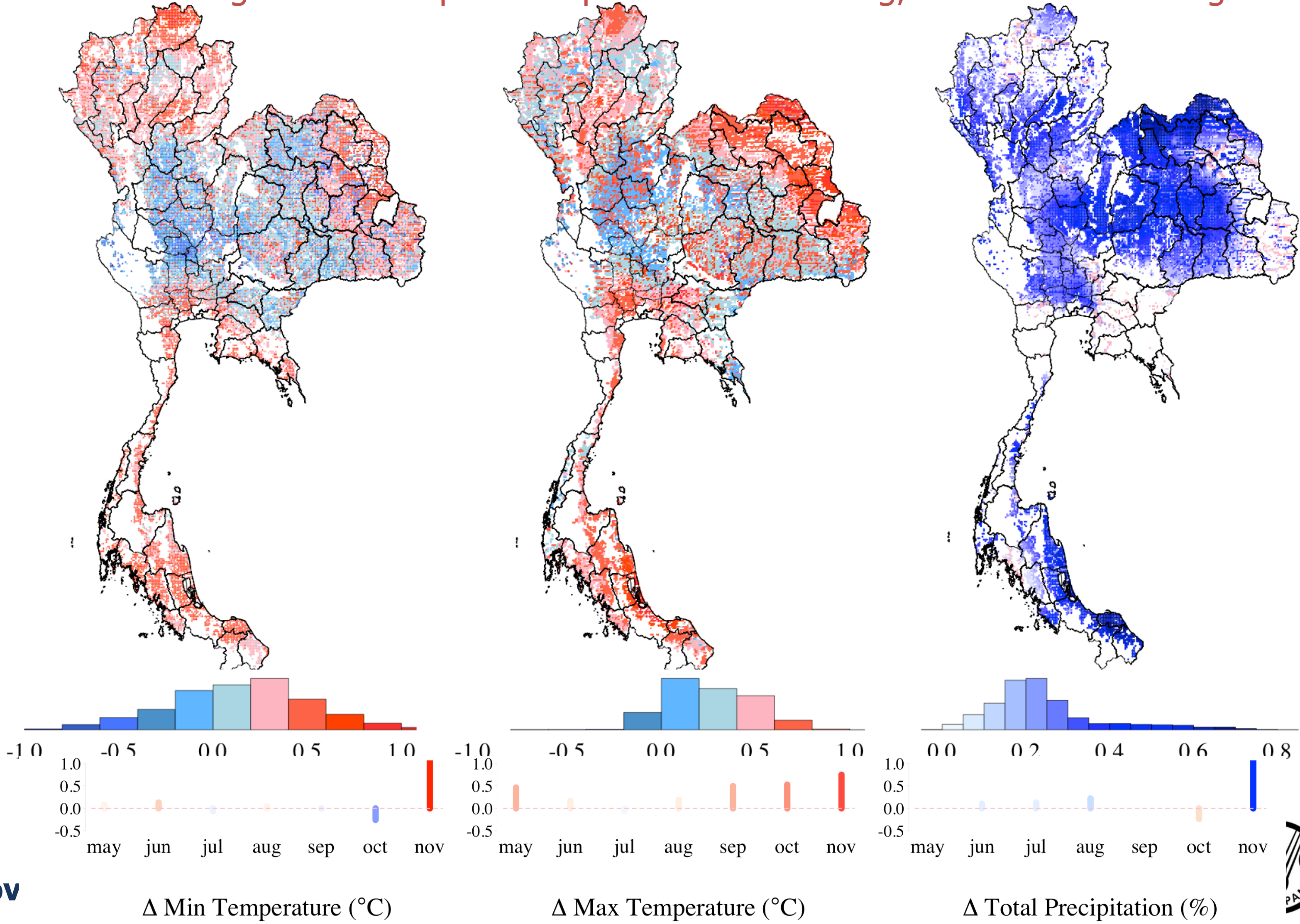
Climate and Rice Yields

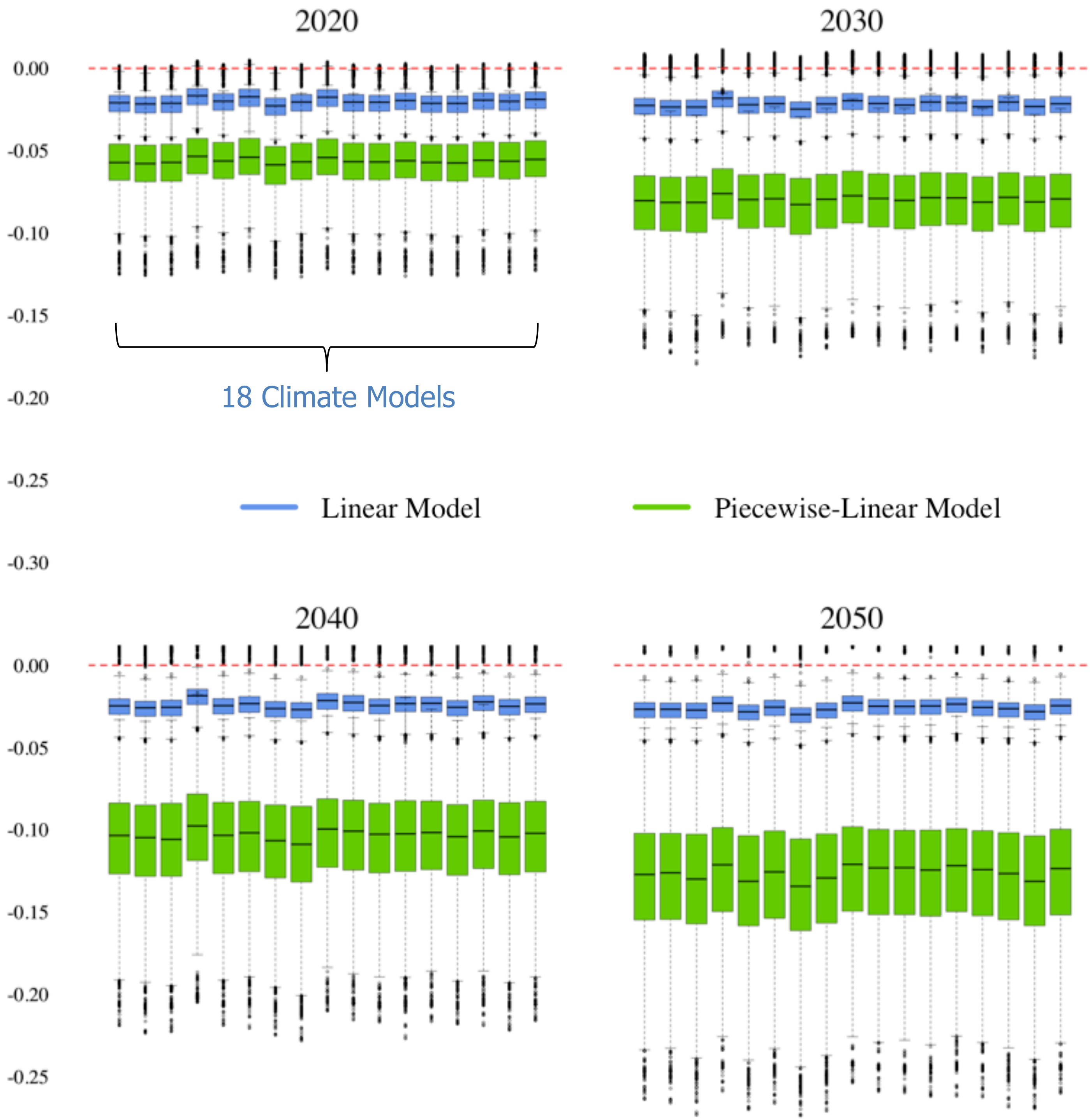


In general, yearly high peaks in min and max temperature, as well as low peaks in precipitation, are associated with lower yields.

Recent Climate History: 1980-2010

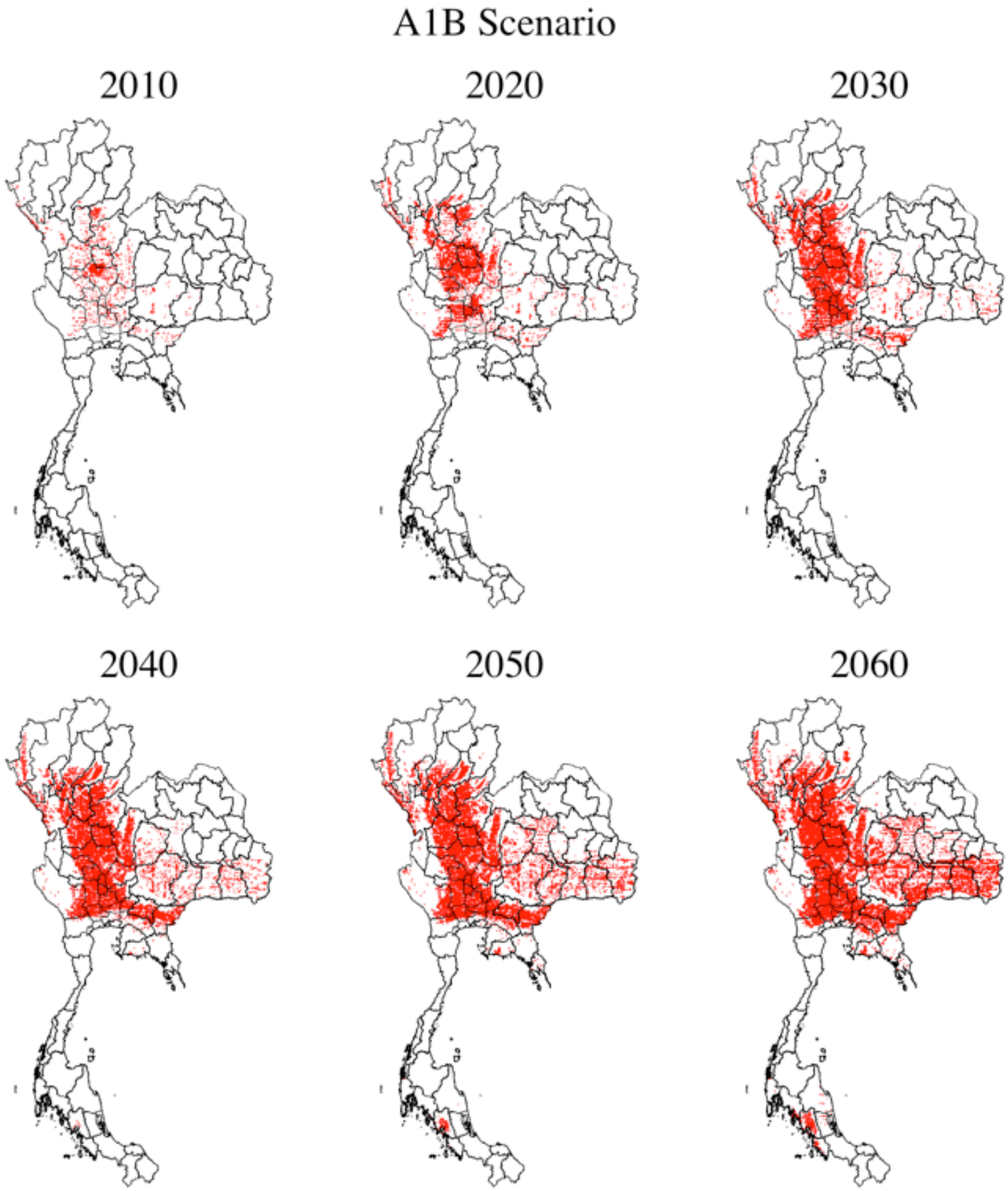
Growing season temperature patterns are shifting, rainfall is increasing.



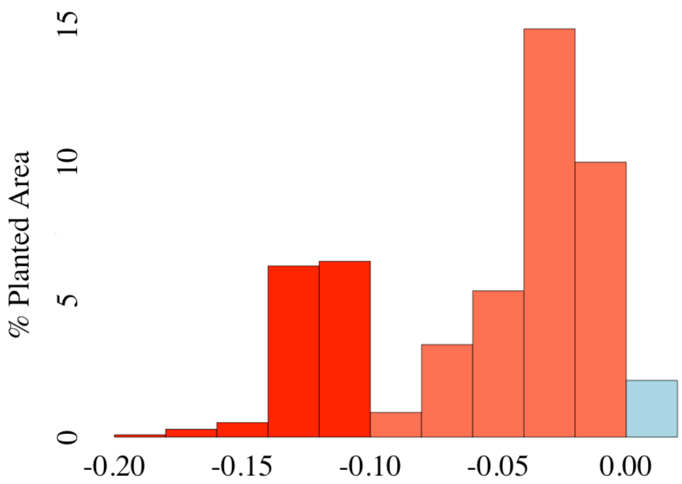


Choice of Model: Little Difference for Climate Models, Big Difference for Yield Model

Rice Growing Area Over the Negative Threshold for Maximum Temperature

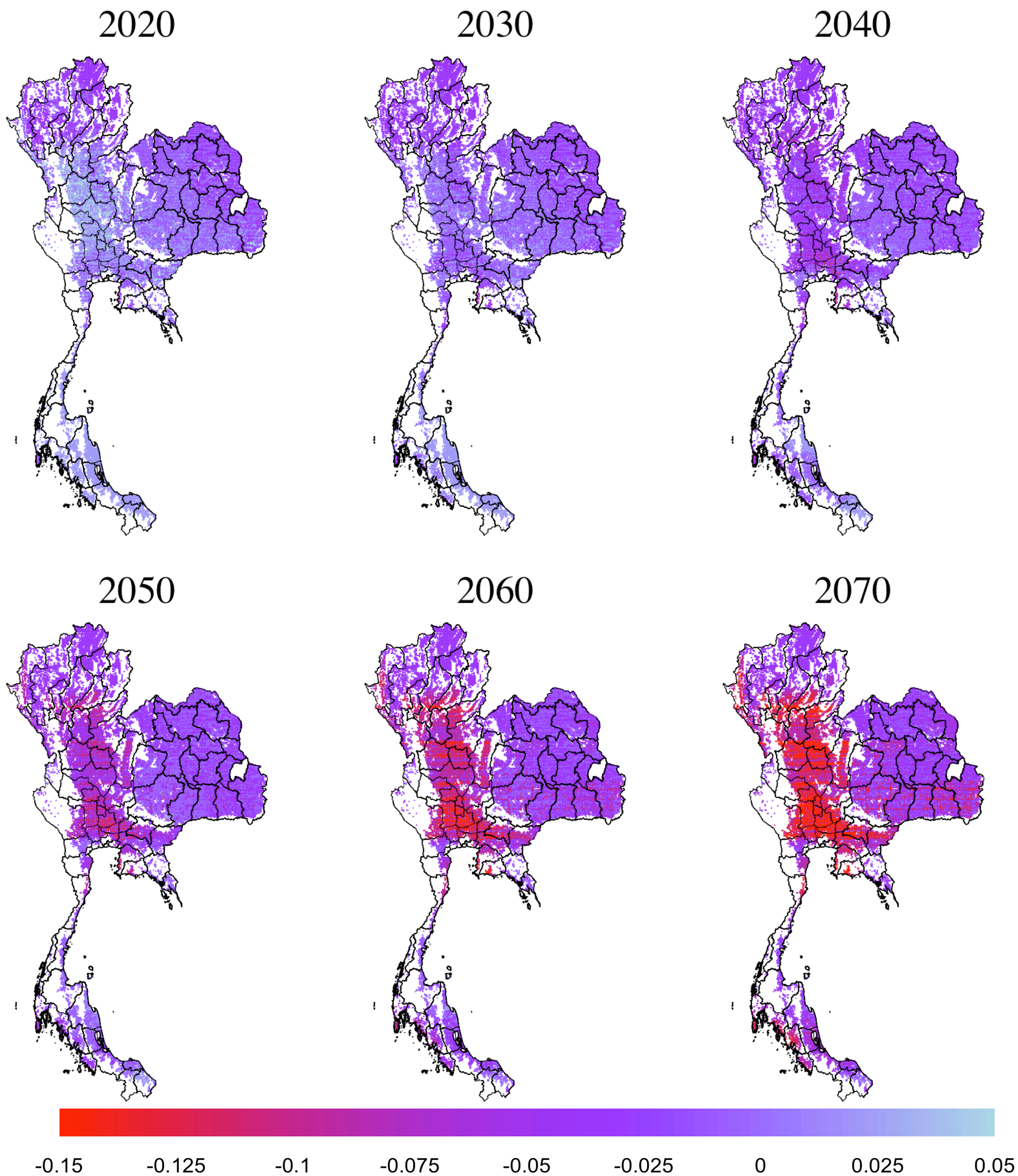


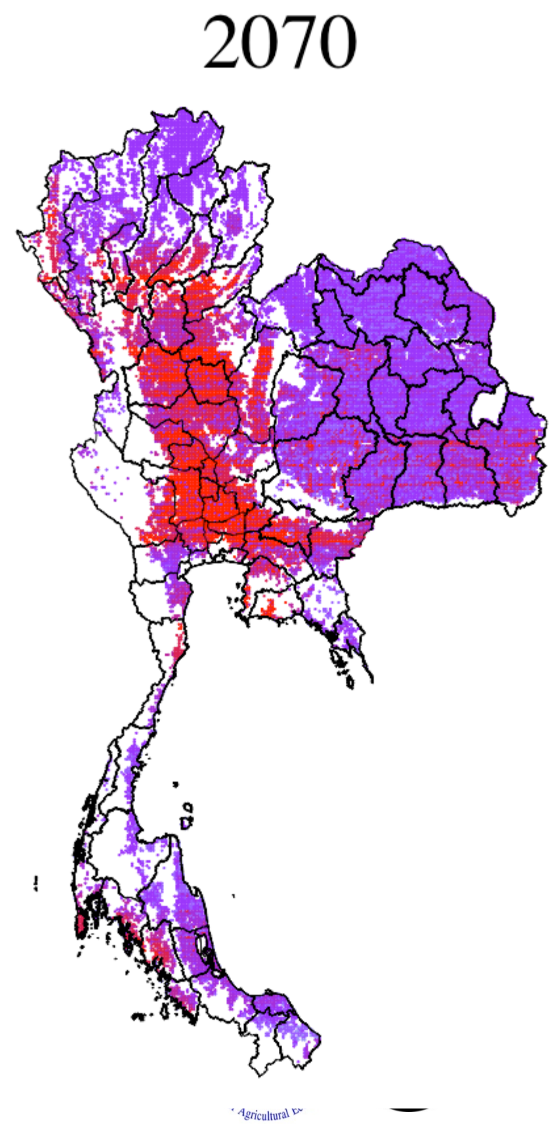
Average Growing Season Maximum Temperature > 34



Estimated Yield loss by Area

Yield Changes: A1B Scenario

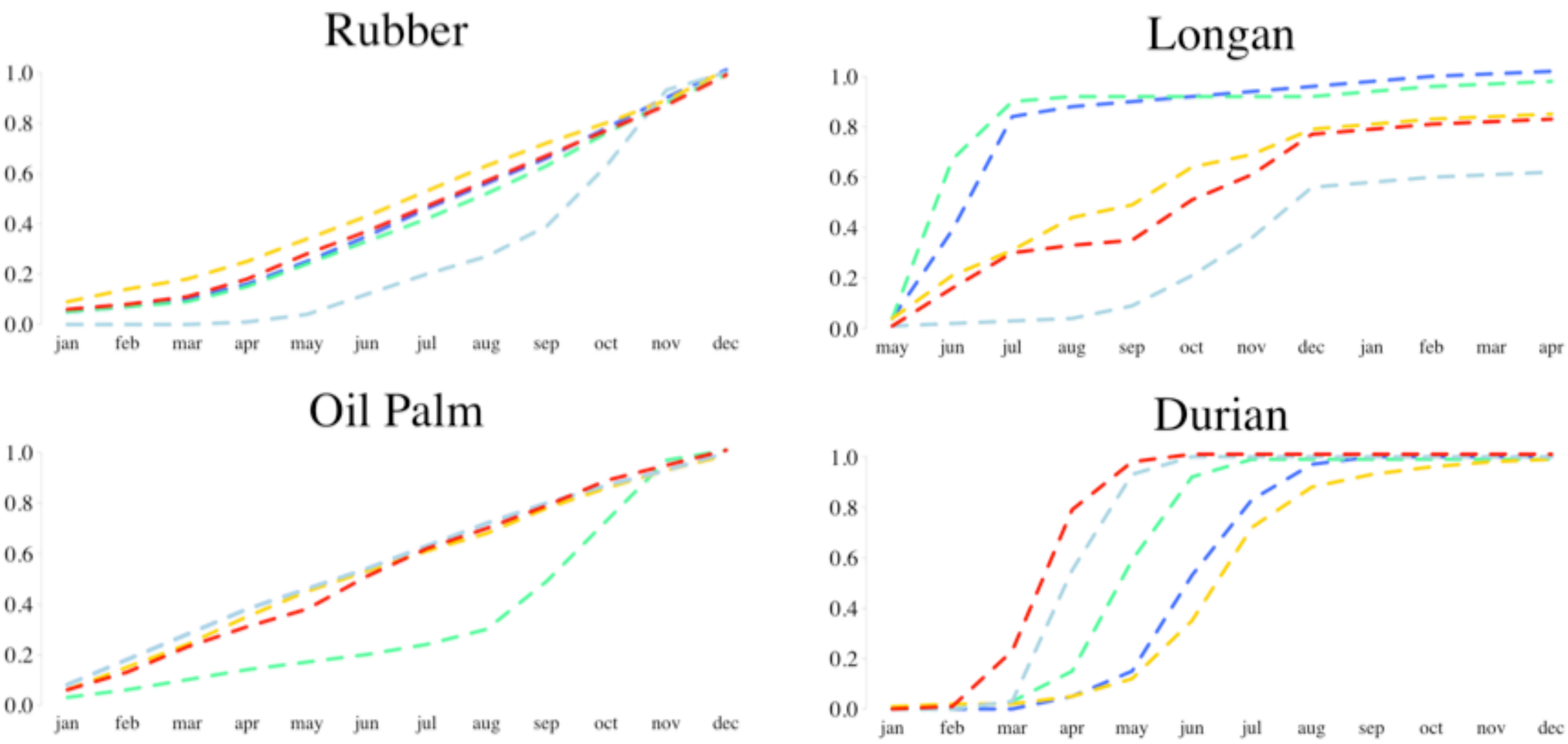




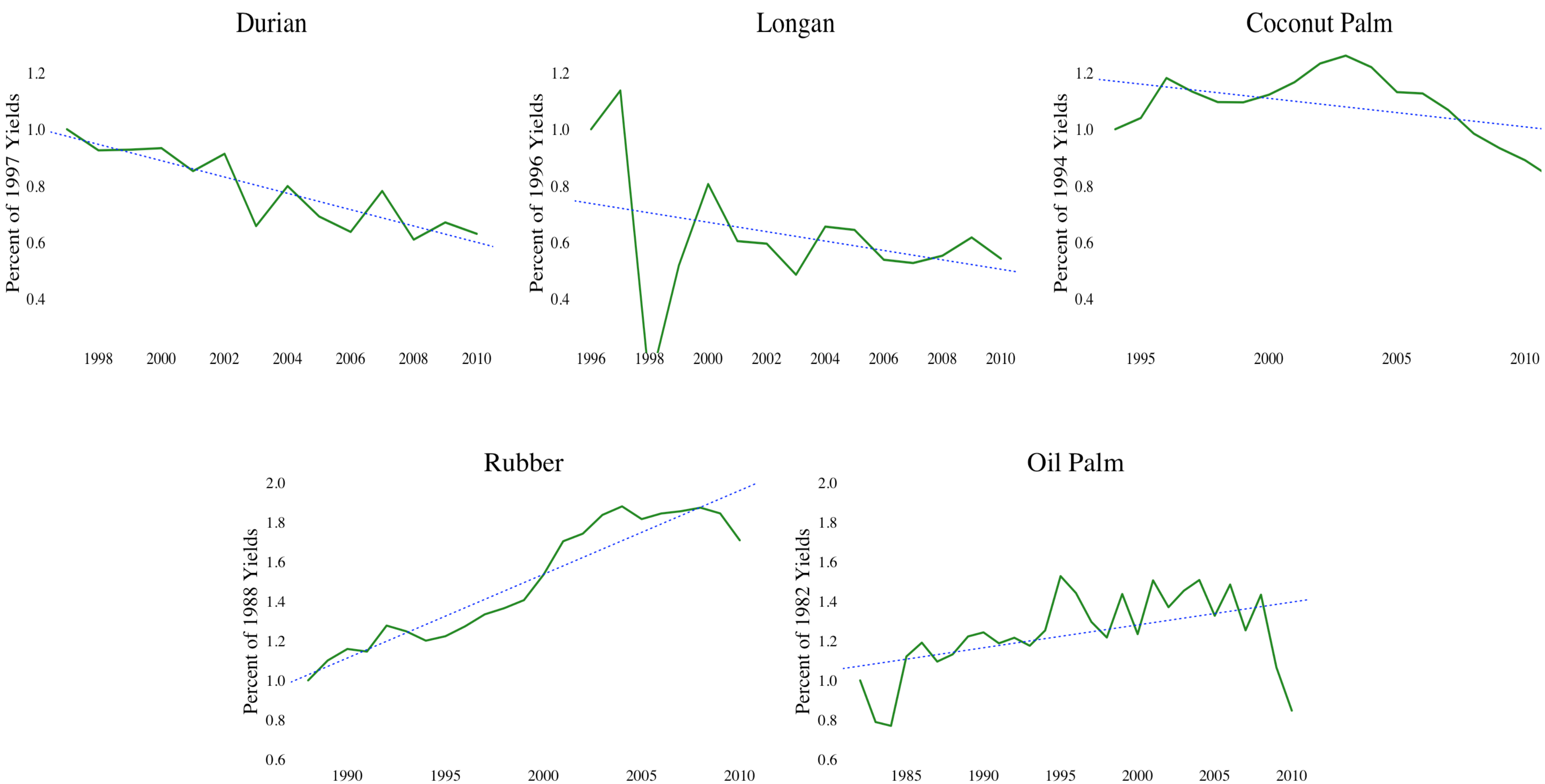
26 November 2012

Tree Crops: Diverse Impacts

Distribution of the harvest by month



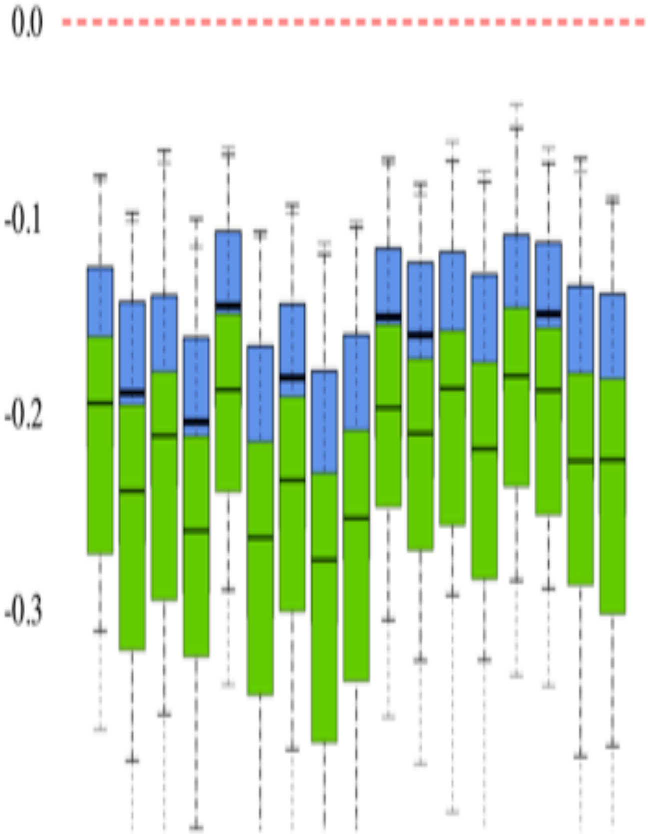
Recent Yield History



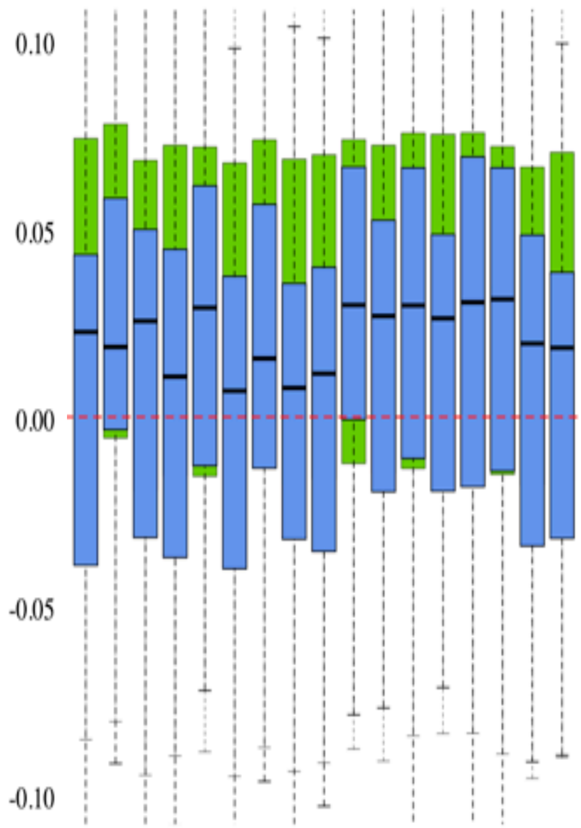
Yield indexes for each crop normalized to 1 in the first year for which data was available.

Yield Effects by Crop and Province: Scenario A1B, 2050

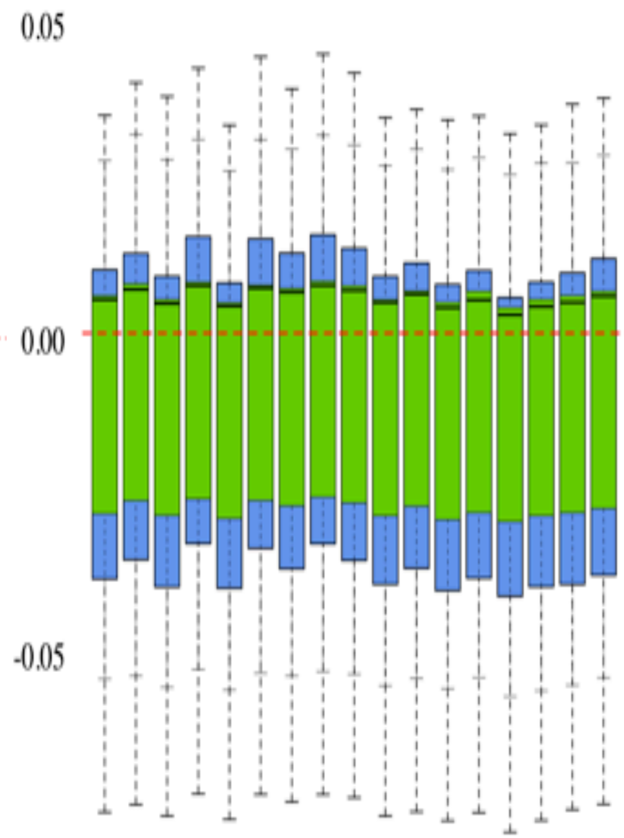
Longan



Durian

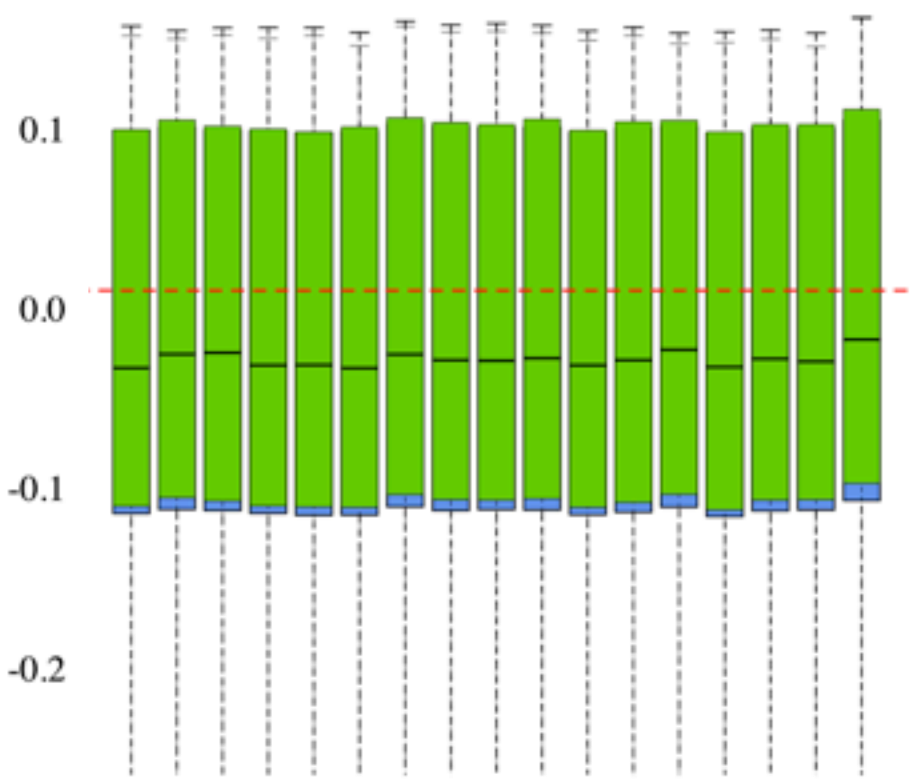


Coconut

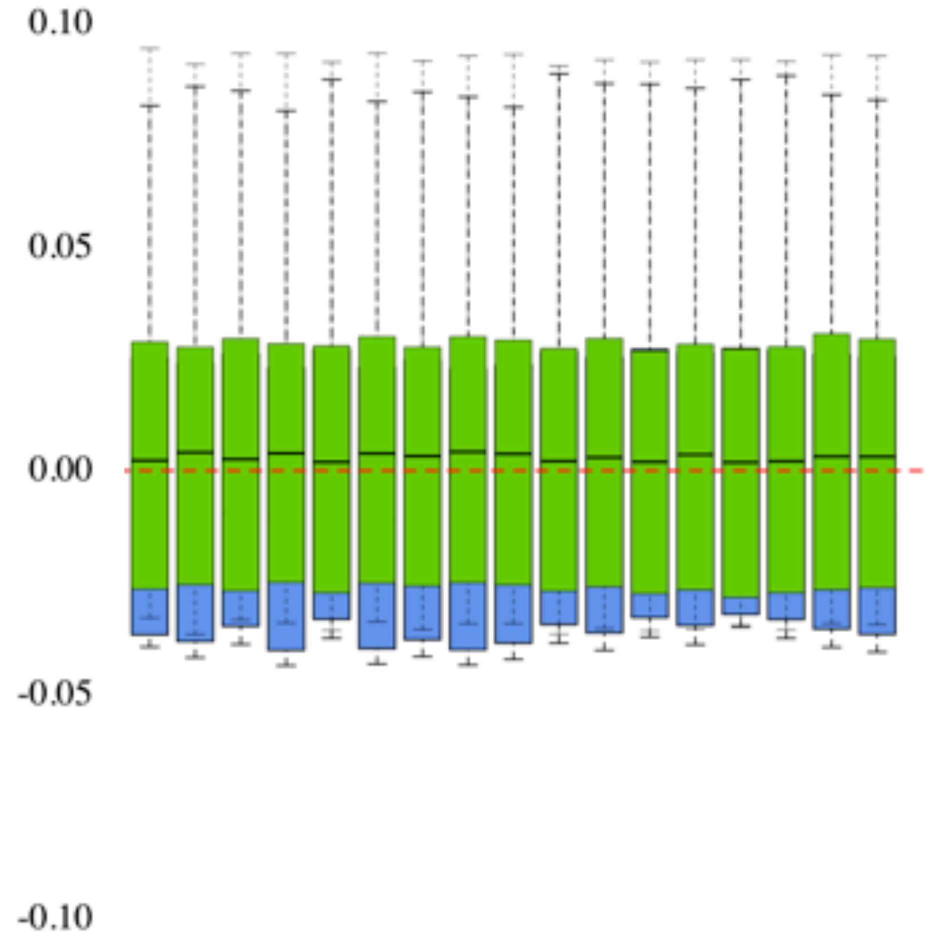


Yield Effects by Crop and Province

Oil Palm

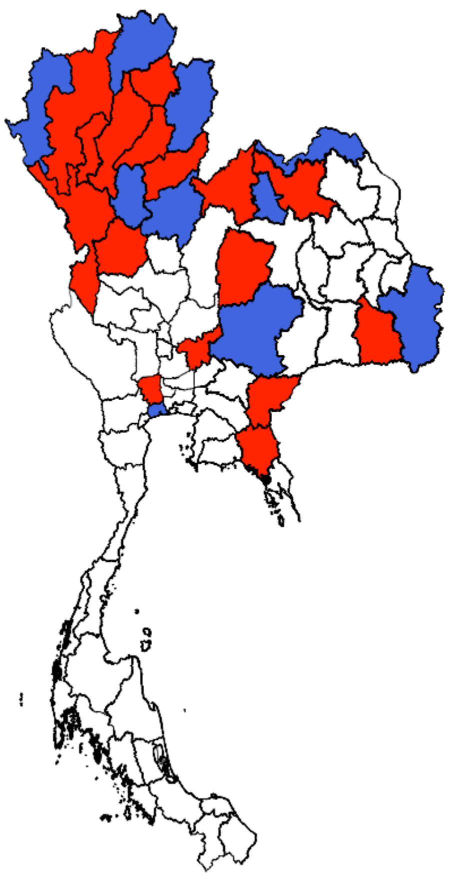


Rubber

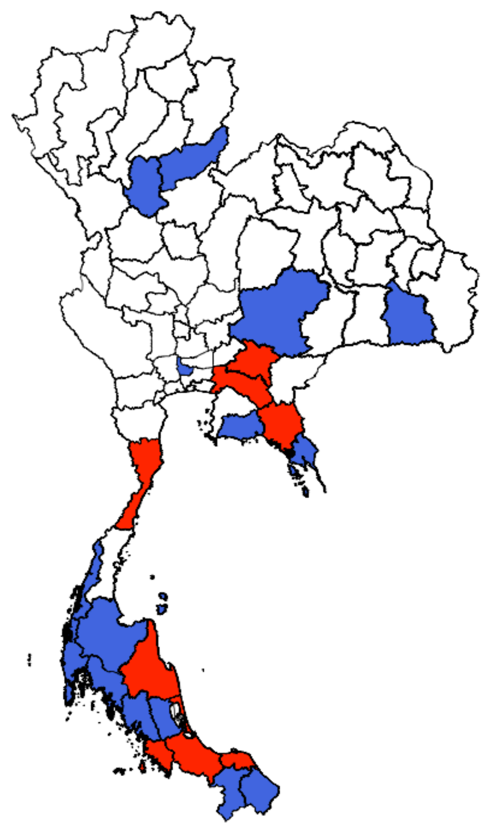


Yield Effects by Crop and Province

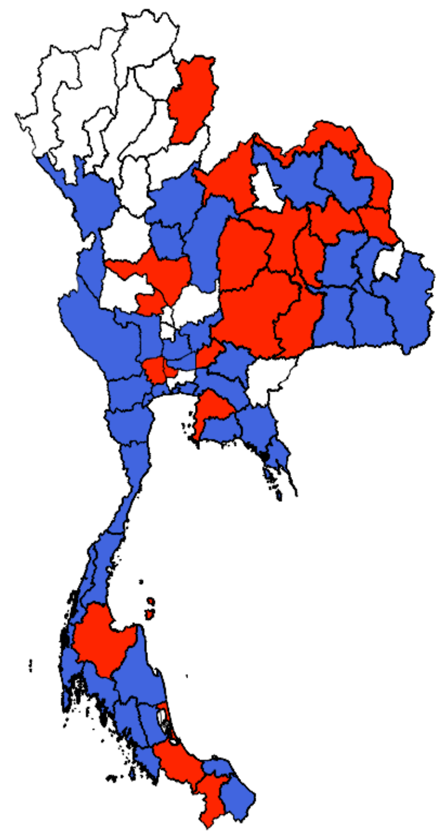
Longan



Durian



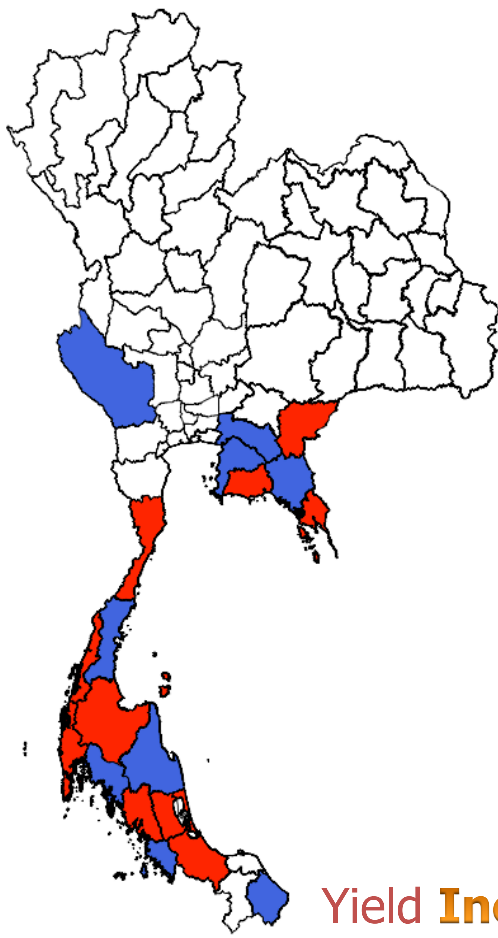
Coconut



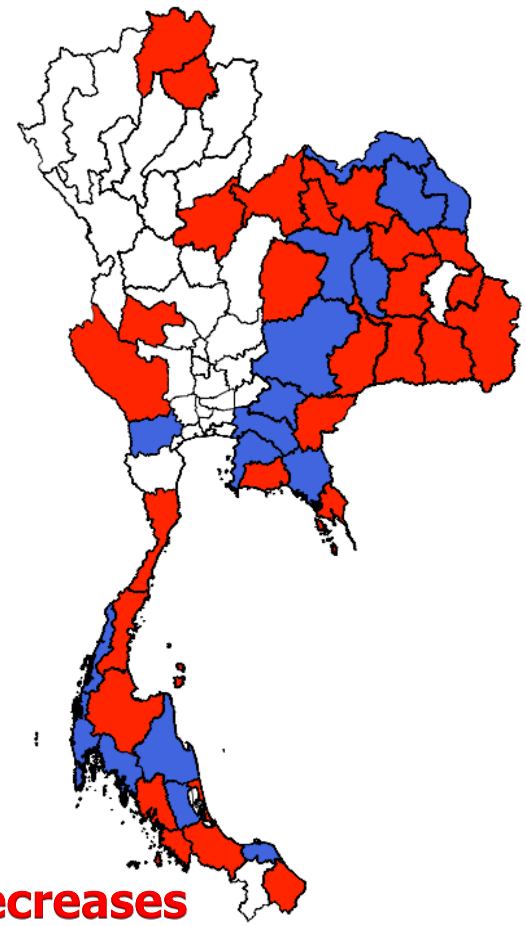
Yield **Increases** and **Decreases**

Yield Effects by Crop and Province

Oil Palm

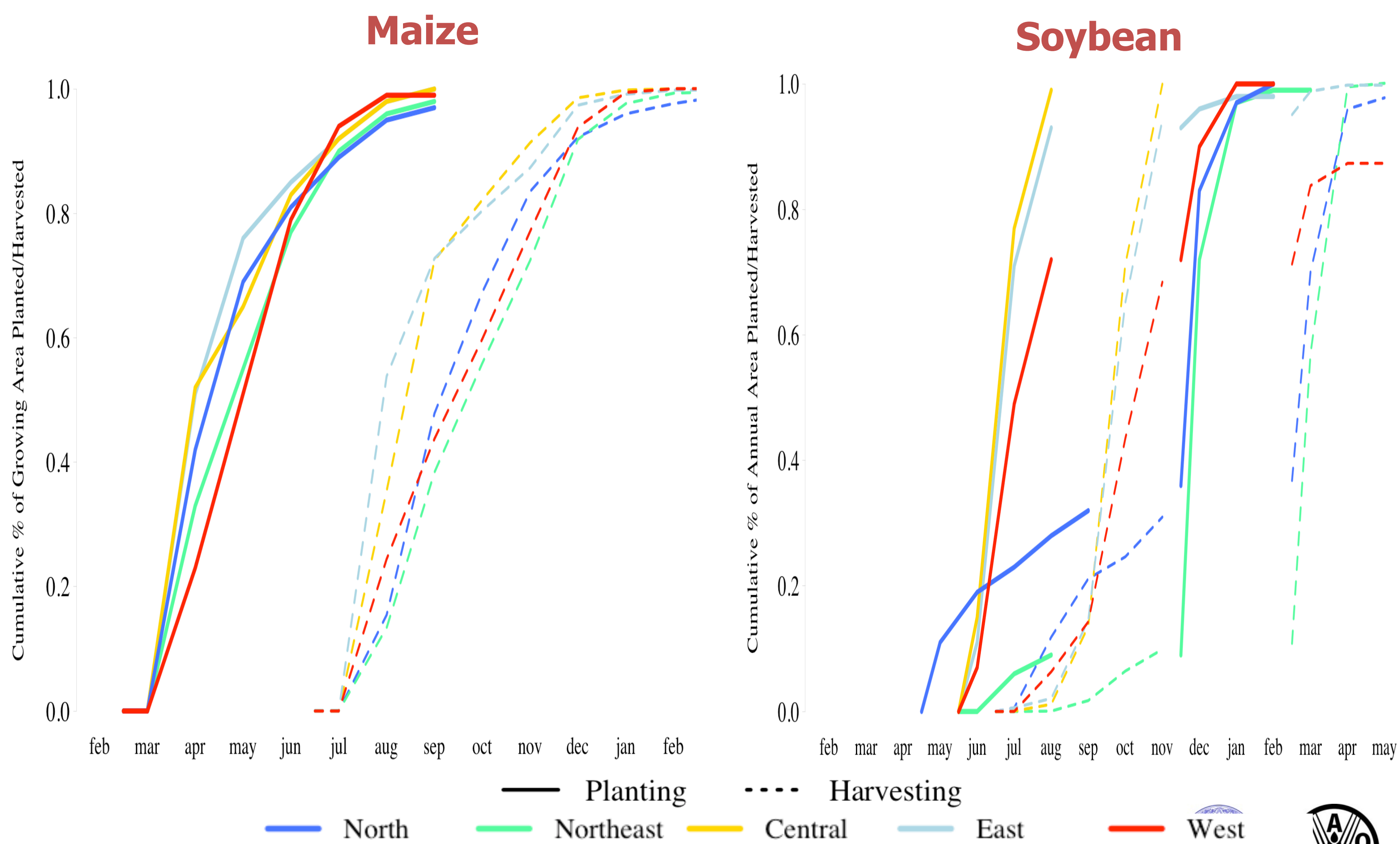


Rubber

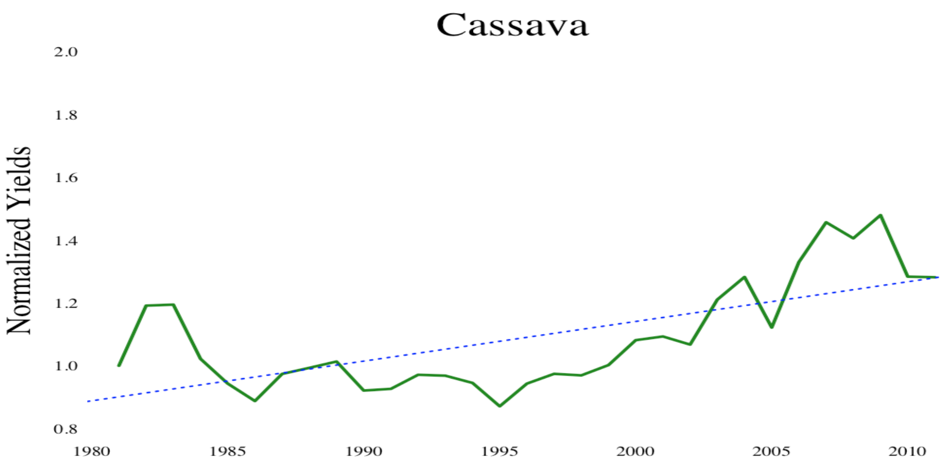


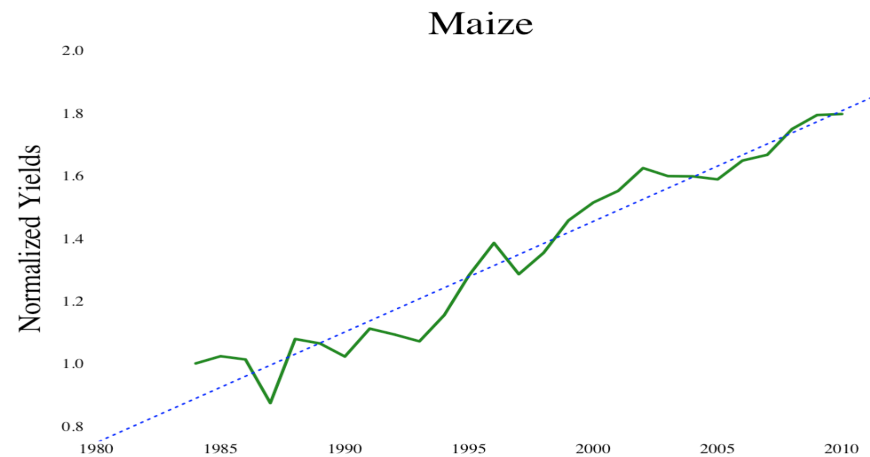
Yield **Increases** and **Decreases**

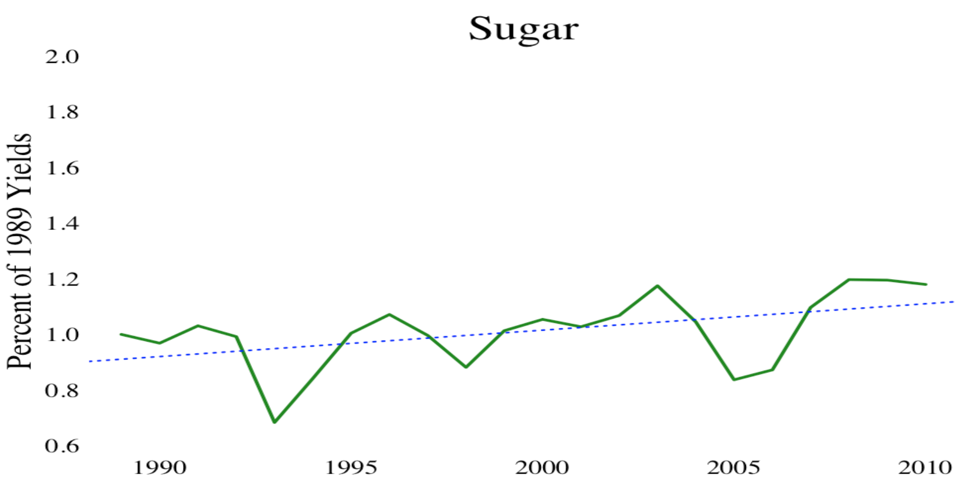
Major Annual Crops: Distribution of the Growing Season

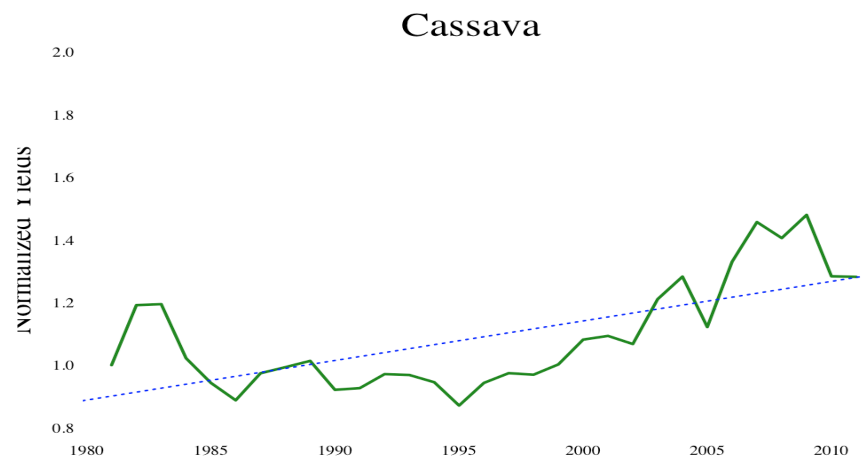


Recent Yield History



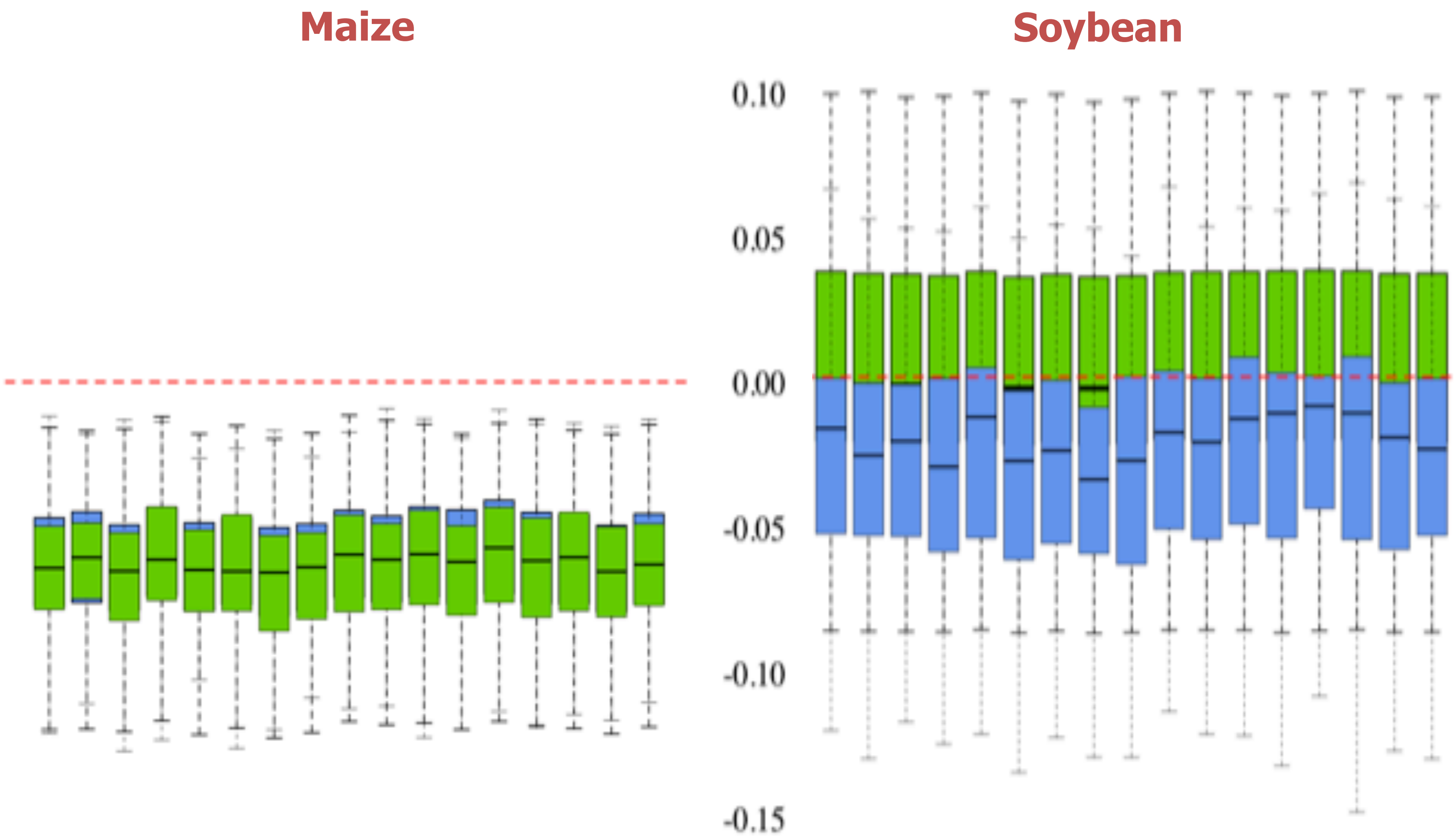






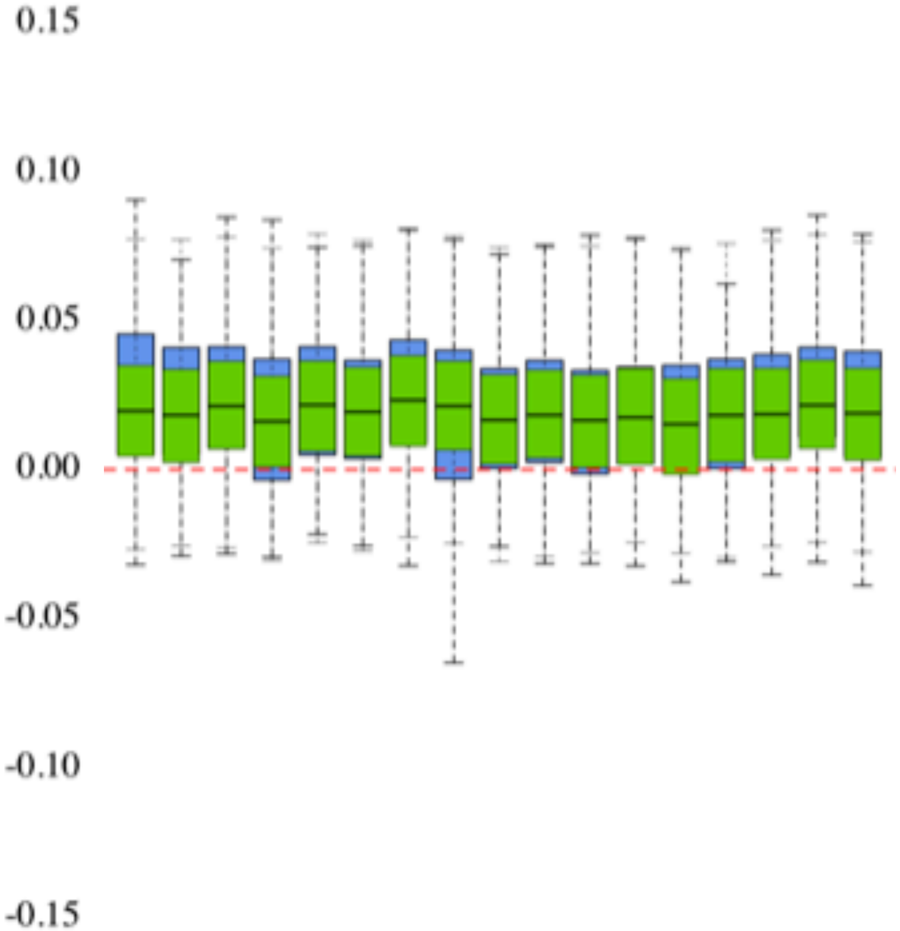
Yield indexes for each crop normalized to 1 in the first year for which data was available.

Yield Effects by Crop and Province: Scenario A1B, 2050

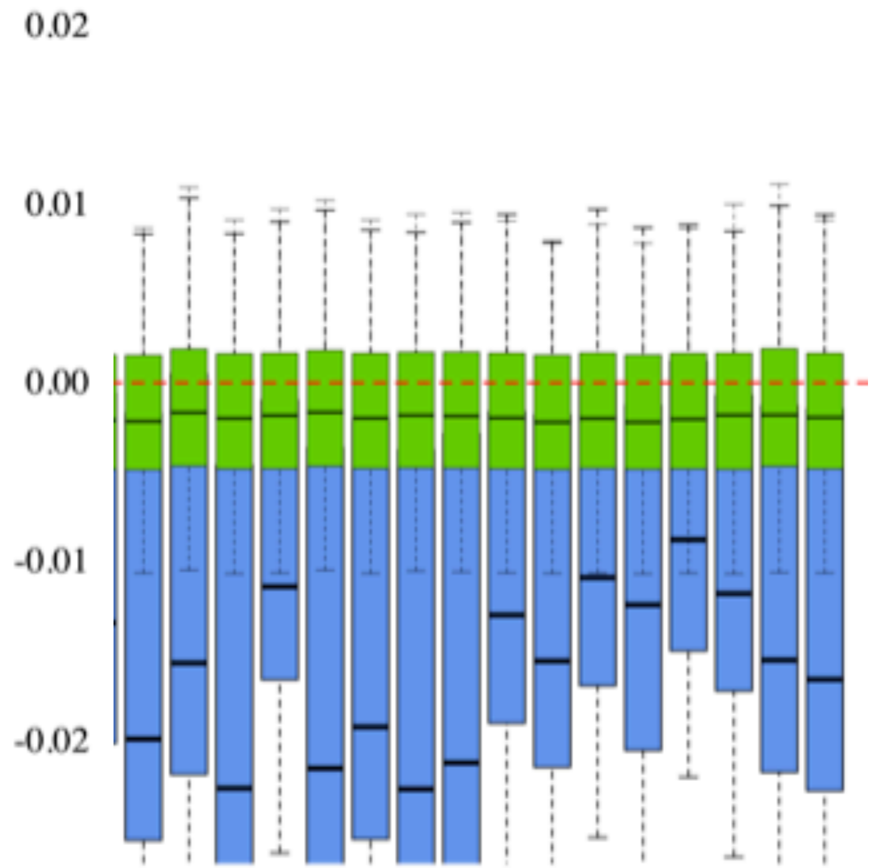


Yield Effects by Crop and Province: Scenario A1B, 2050

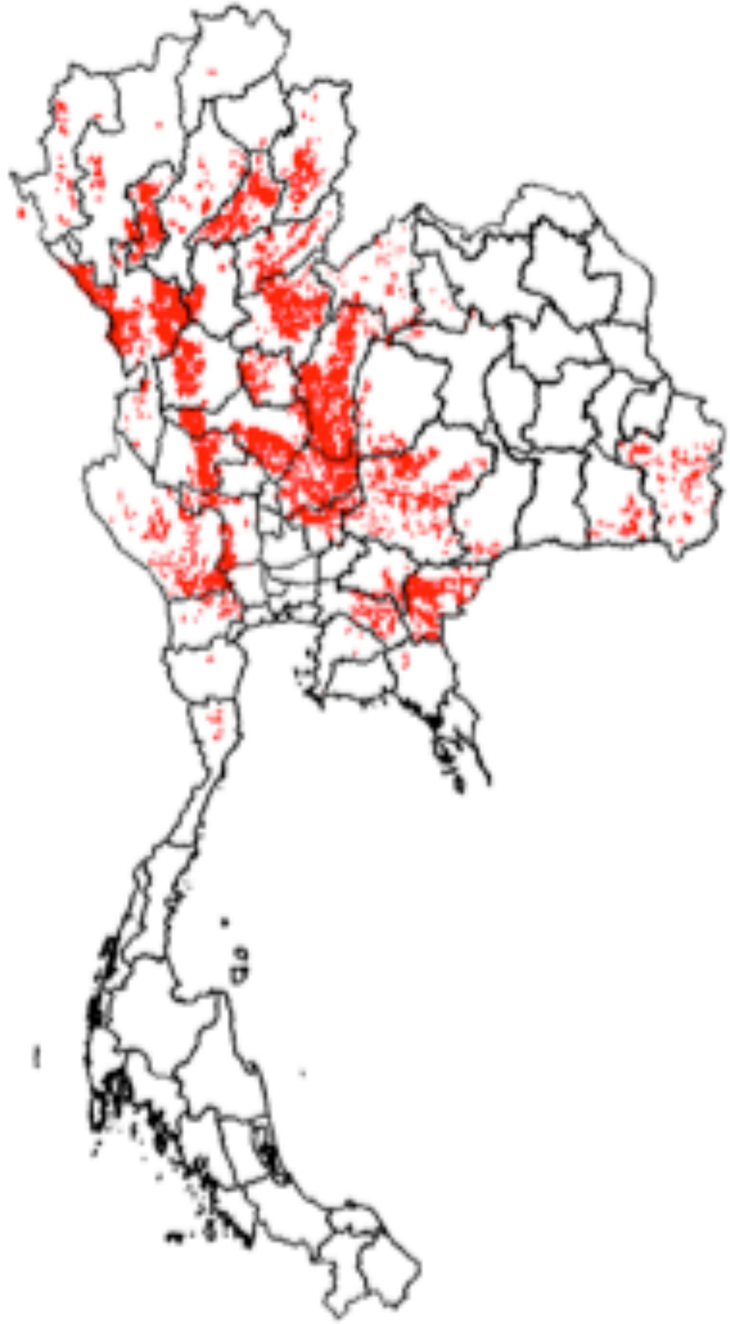
Cassava



Sugar



Maize Area Above Maximum Temperature Threshold 2050 (A1B)



Highlights of Crop Results

1. By 2050, 10-15% of wet-season rice yields could be lost unless adaptation measures are taken.
2. Rain-fed rice is the crop most vulnerable to water shortages.
3. Second season rice grown with irrigation will be more robust to shifting climates than wet-season rice, but 2050 losses could be 5-10% without further adaptation.
4. Cassava is robust to rising temperatures, with 2-5% higher 2050 yields.
5. Maize is most robust to water shortages, but it is highly sensitive to rising maximum temperatures and overall 2050 yield losses could exceed 5% in most areas.
6. Longan appears to the most vulnerable tree crop, with 2050 yield losses potentially exceeding 20%.
7. Other tree crops such as rubber, oil palm, and durian will see diverging yield trends, about half of growing areas see up to 5% higher yields while the others face comparable losses

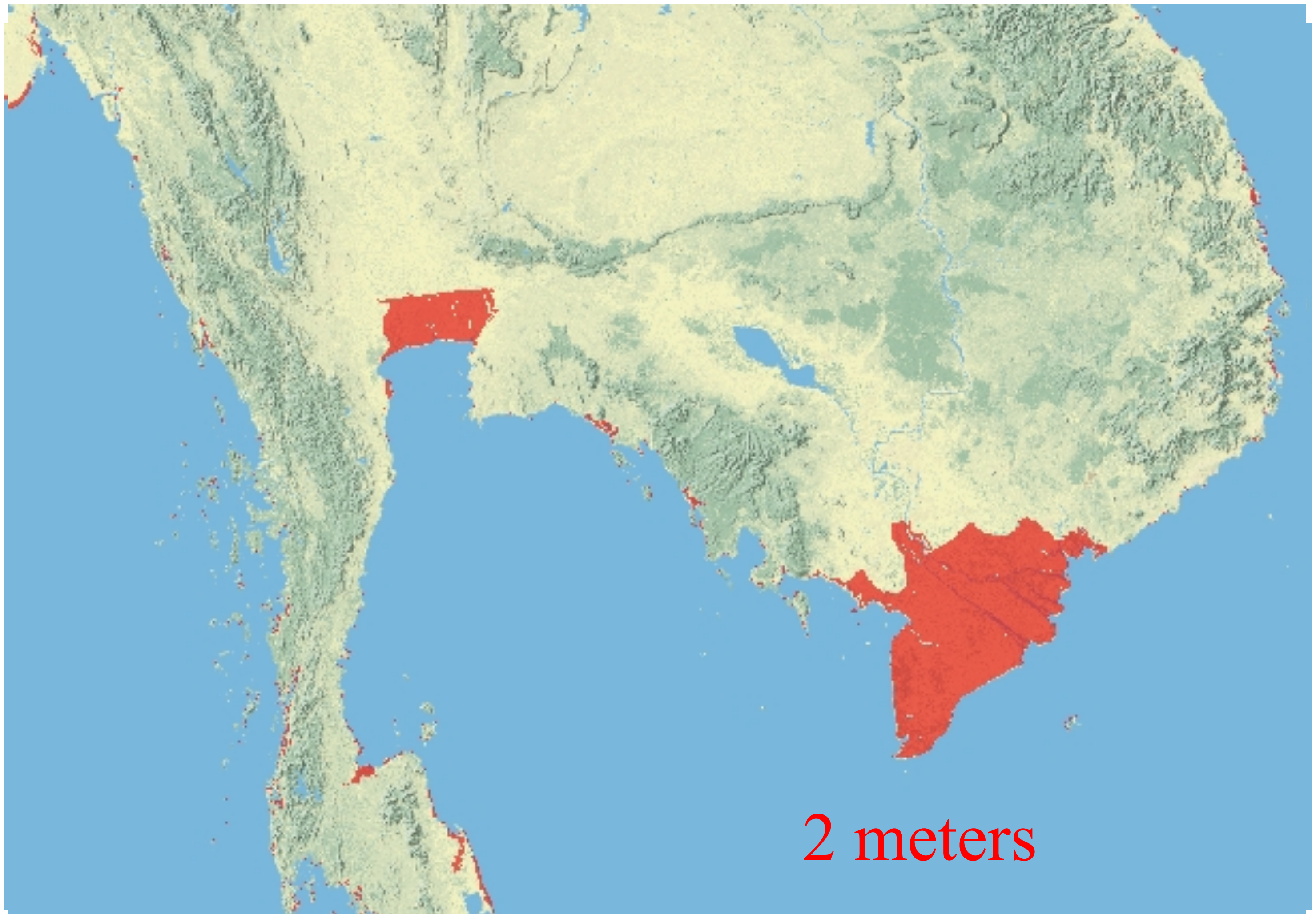
Survey of Policy Options

Mitigation versus Adaptation agendas:

- National and global greenhouse gas mitigation policy is very challenging,
- but every country has a responsibility to protect itself from climate change.
- For this reason, there is no need to wait, and indeed the cost of early action is lower.

Example: Sea level
GIS Simulated Inundation

What a difference a meter makes.



Policy Principles

1. Inform stakeholders about climate risk and public commitments to adaptation
2. Protect essentials: food and health security
3. Reduce adjustment costs, especially for the poor, but do not subsidize risk taking
4. Limit resource rivalry, locally, nationally, and regionally
5. Facilitate private sector participation in adaptation, risk taking, and innovation.

Options for Adaptation in Agriculture

- Extension Services
- Public Information
- Water Management and Infrastructure
- Genetic and Related Research
- Diversification
- Insurance
- Emergency Assistance

Extension Services

Thailand already has a wide array of services to promote farm-level productivity, and extension services will be the first line of defense for climate adaptation in agriculture.

The results of this research make it clear that services will need to be <u>differentiated</u> for local conditions and risks.

Public Information

Investments in information can reduce the risk and costs of private sector adaptation, shifting the adjustment burden from the public sector.

- Weather Forecasting
- Early Warning Systems
- Risk Mapping

Climate change requires a new generation of forecasting and dissemination capacity.

Our research shows that more spatial detail is needed to identify and respond to risk.

Water Management and Infrastructure

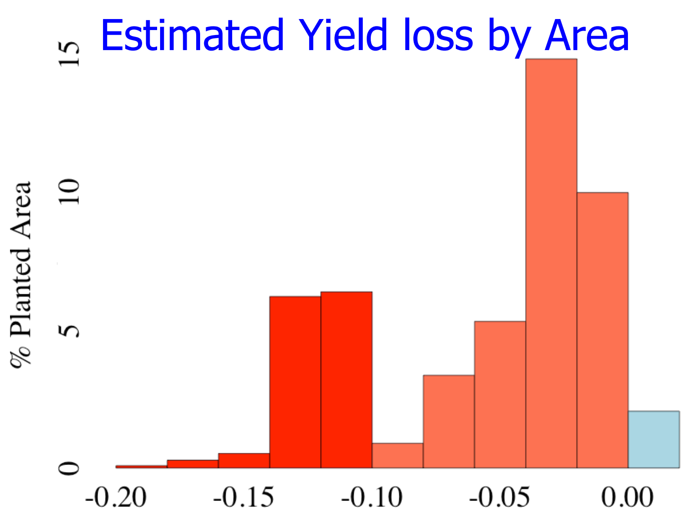
- Our results on water vulnerability show that significant expansion of storage and allocation capacity will be needed to manage climate risk.
- Of special importance will be water management to deal with extremes of scarcity (drought) and excess (floods).
- In all cases, both green and grey solutions should be considered.

Genetic and Other Technical Research

- There is a global research industry dedicated to developing adaptable genetic varieties of food crops, horticultural products, and livestock.
- Because of the risk patterns revealed in our research, it is clear that Thailand should be an active participant.
- Fortunately, the Kingdom already has very advanced agrifood R&D capacity, both public and private.
- More investment in this knowledge-intensive, high wage sector could yield global competitive advantage from discoveries and new, climate-resilient products.
- In this way, the challenge of climate adaptation can become a golden opportunity for innovation.

Diversification

- Because the impacts of climate change are so diverse, some regions will have to shift agricultural practices.
- Agricultual policy can help by: Reducing information costs, credit and technology constraints.
- Our results provide a roadmap for this.
- Triage approach to adaptation.



Insurance

- Evidence suggests that farmers underinvest because of high and non-diversifiable (systemic) risks, particularly weather and market prices.
- Governments can increase private sector commitments to new and improved technology by pooling risk nationally.
- This can be combined with public investment in innovation and information on private risk-reducing investments.

Emergency Assistance

- A huge agenda for Thailand: Existing emergency management systems will need determined and sustained expansion/improvement.
- Be selective: Some interventions are better than others (buffer stocks vs. export bans).
- Basic principle: Short term intervention, consistent with long term expectations.

Summary

1. Benefits of investing in climate adaptation can far outweigh its cost.
2. Policy can play an essential role in agrifood adaptation, reducing it's long term costs.
3. Because impacts will be very unequal, careful targeting, supported by high quality information, is needed.
4. Private agency can bear much of the adjustment costs.

Thank you