Challenging Agriculture's Long-Term Path

Roz Naylor, Stanford University

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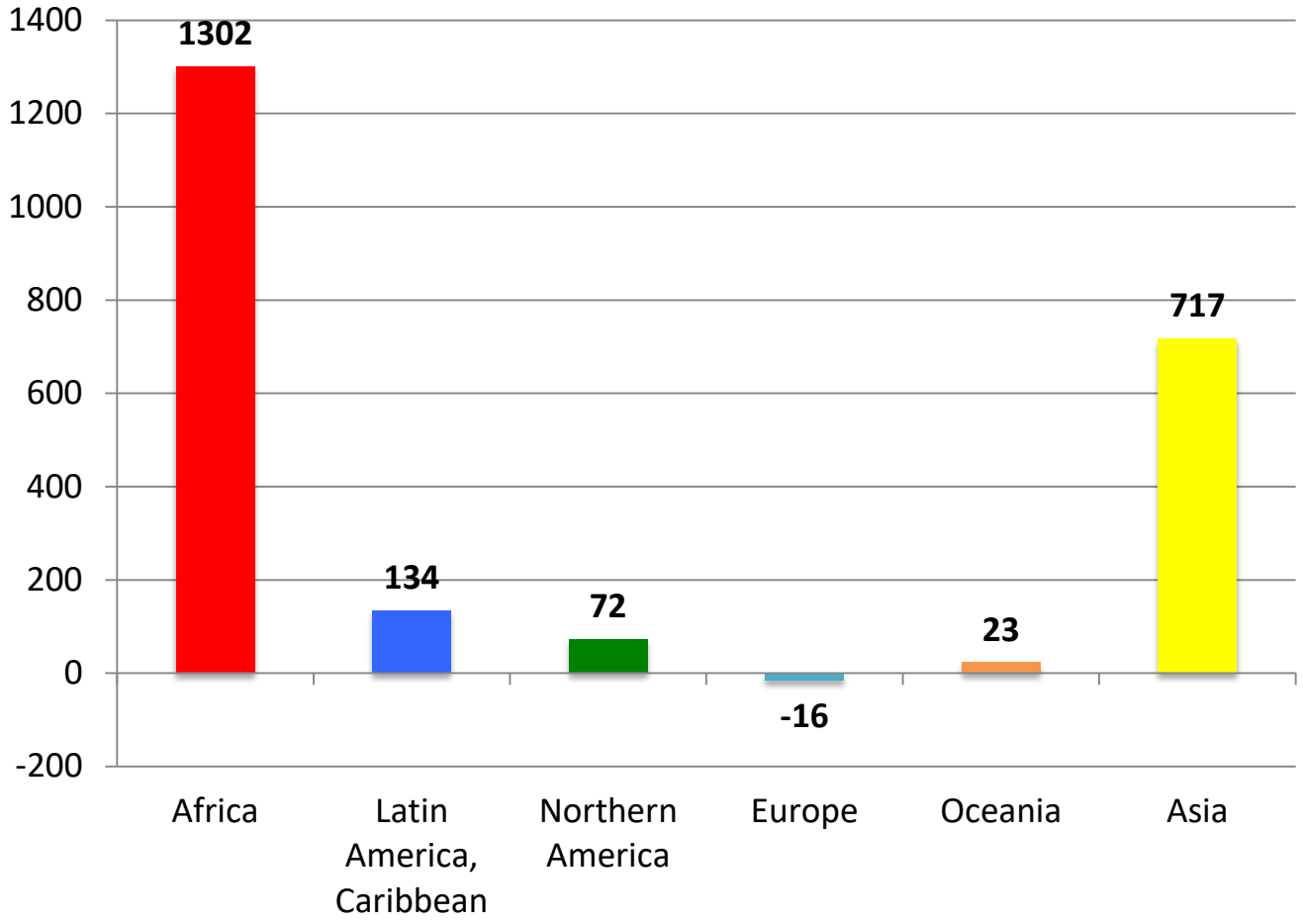
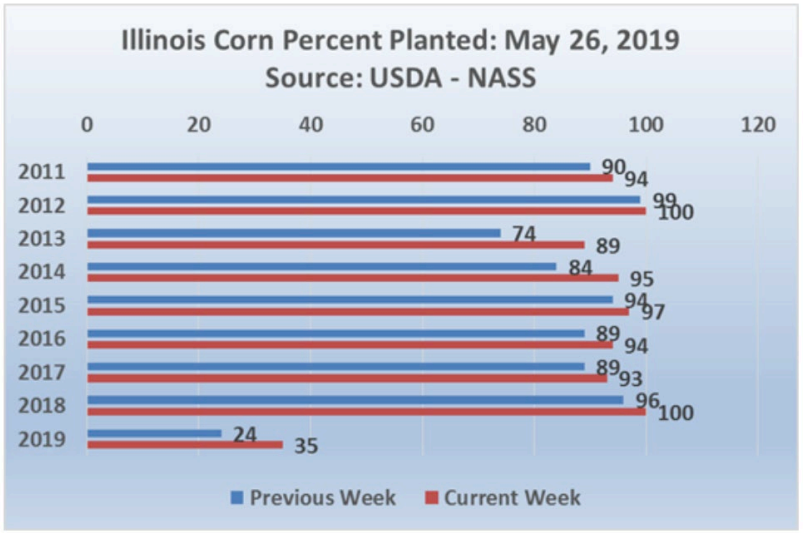
10 billion people by 2050:
Where will the additional people be born?



Population change between 2018 and 2050 by major region (millions)

Changing Nature of Demand

"Over the last week, rainfall totals in the region have been running at 400% to 600% above normal," according to the National Weather Service (May 29, 2019)

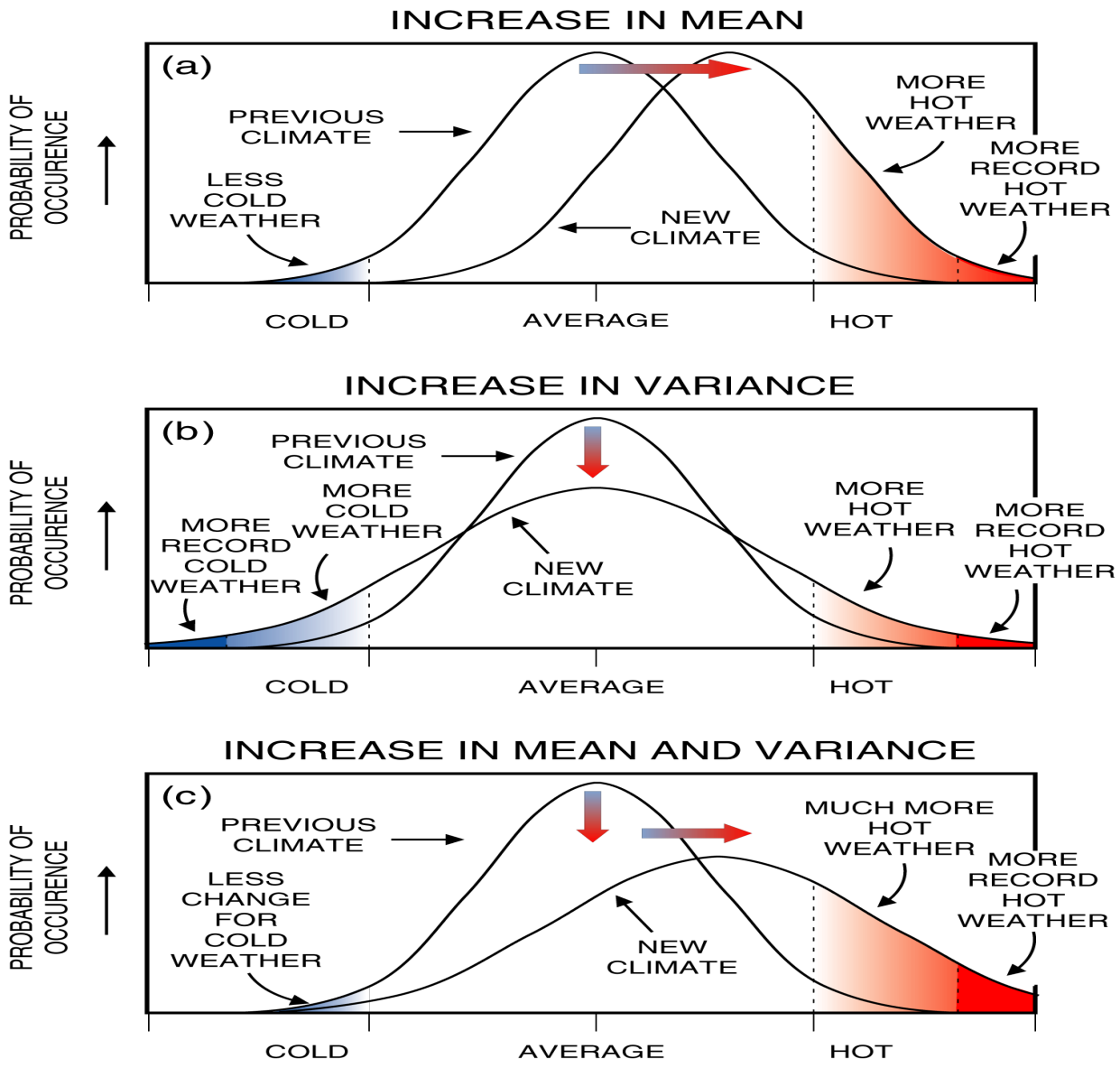


Graph from USDA- National Agricultural Statistics Service.

>1000 tornado reports (Jan-May, 2019)

"Corn prices jump to 3-year high amid extreme wet weather," by Emiko Terazono.

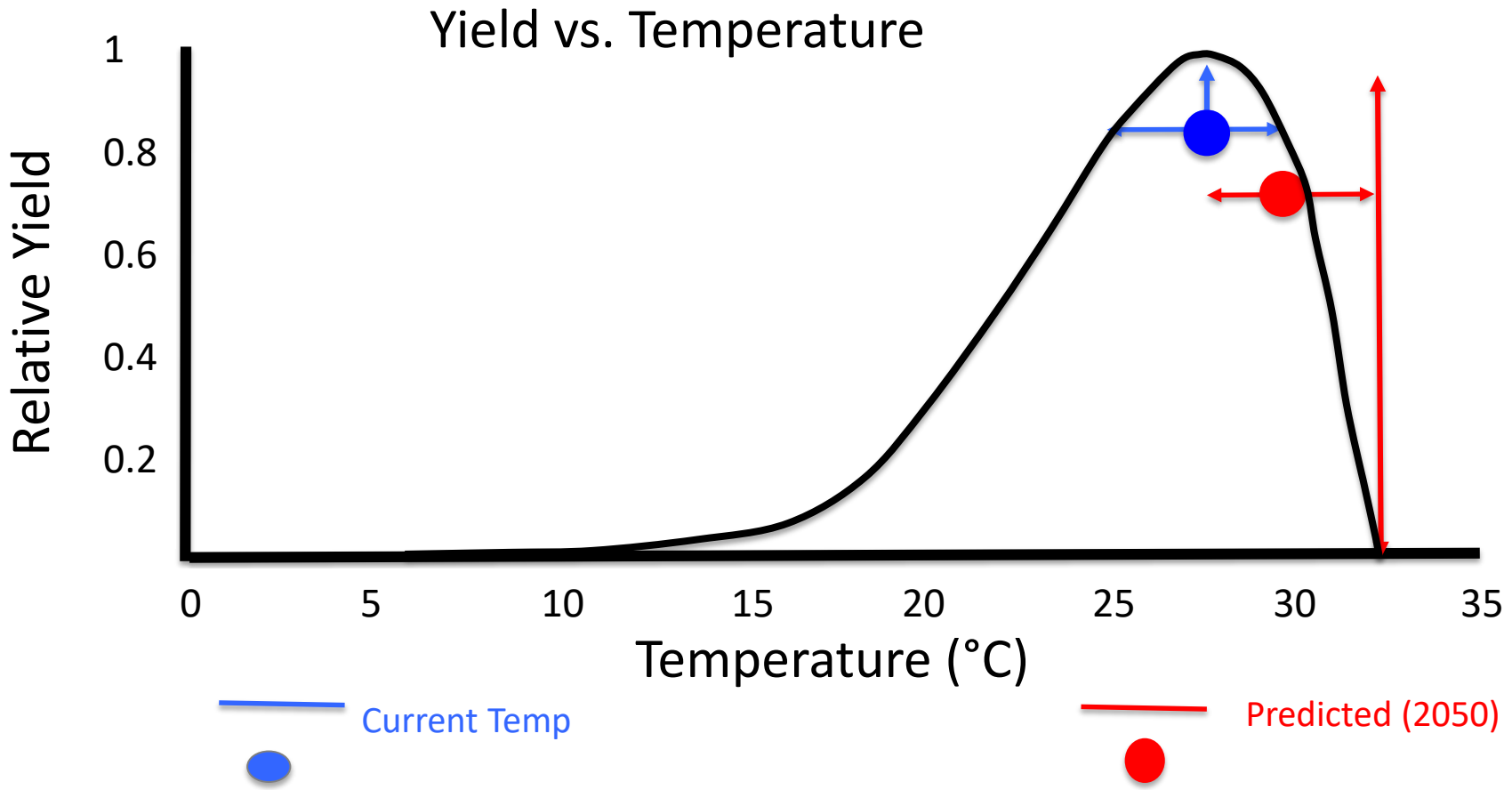
Climate Change leads to Temperature Extremes



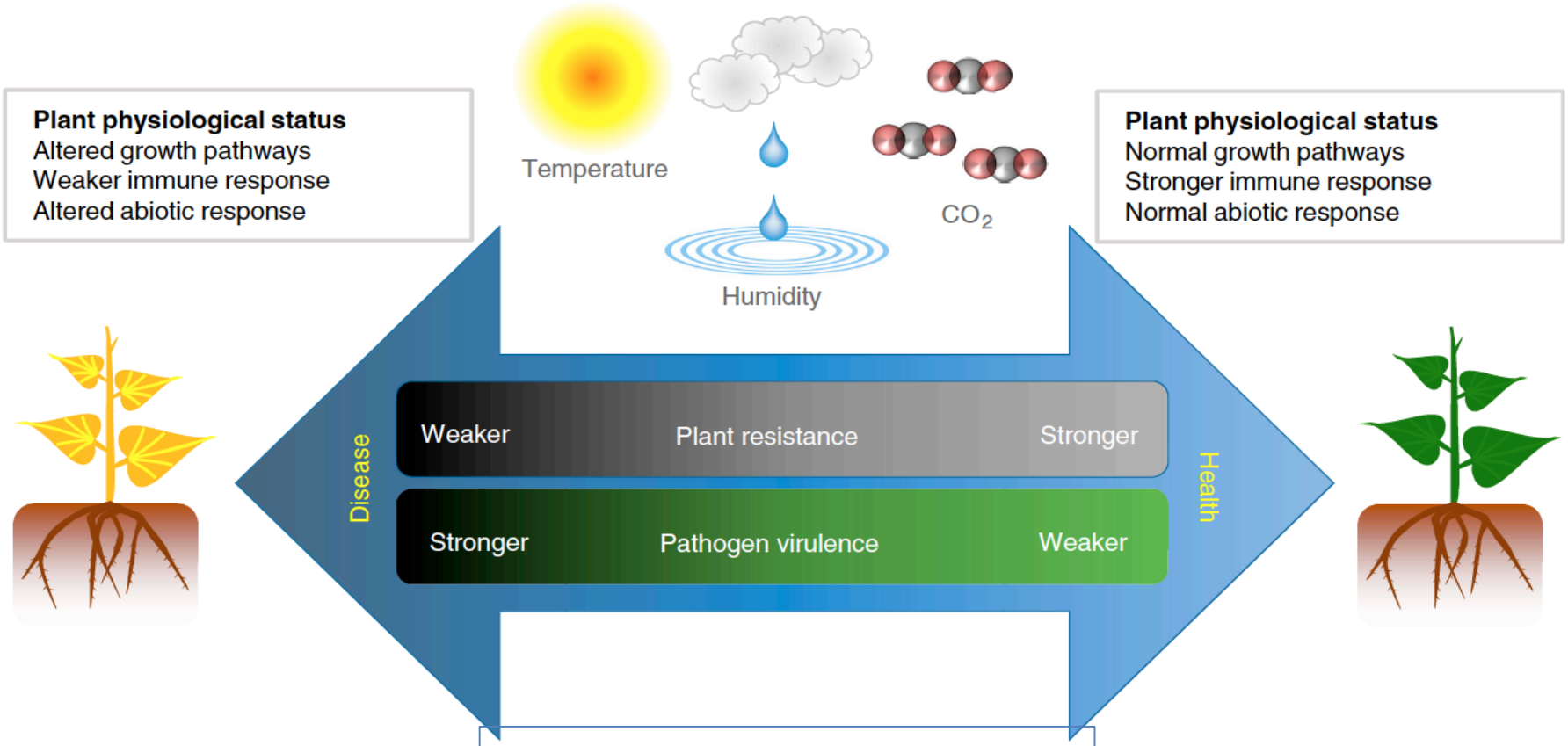
Courtesy of
Dr. John Ingram,
Oxford University

Higher Mean Temperature Raises the Yield Variance

(Mid-Latitude Grain Production)



Climate change impacts on crop pathogens and pests



-Insect, weed and crop range shifts
-Reduced winter fallows
-Insect herbivory

Src: Velasquez et al Current Biology 2018

Policy-Induced Price Volatility

- Governments protect special interests (farmers, consumers, agro-industry)
- Global market volatility increases with simultaneous shocks in large trading countries
- Countries stabilize domestic prices, making world prices more volatile (e.g., ban on exports)
- High prices/spikes hurt consumers, risk of food riots
- **Volatility creates uncertainty for producers, agro-industry**

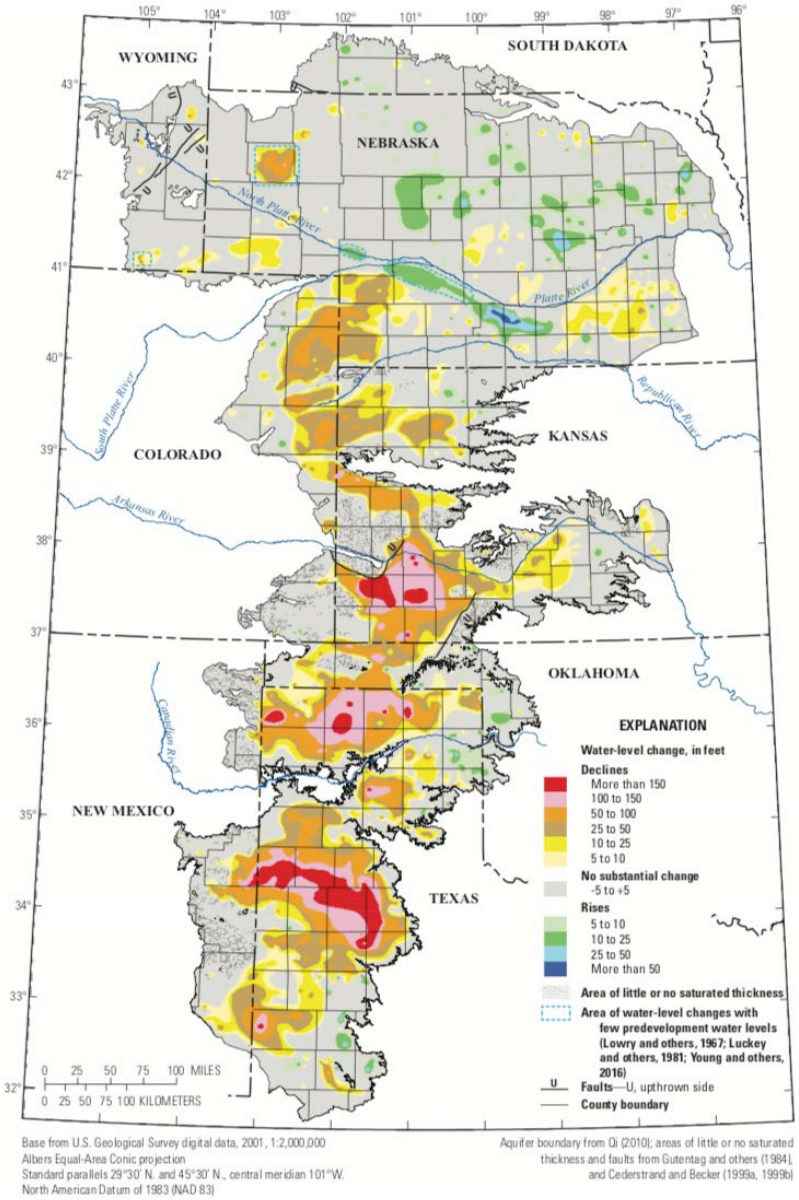


Figure 1. Water-level changes in the High Plains aquifer, predevelopment (about 1950) to 2015.

Src: USGS

Risks of Groundwater Depletion

- India is the world's largest user of groundwater
- Exceeds extraction of U.S. and China combined
- 90% used for agriculture (wheat, rice, sugar…)
- Deep tube wells: 100,000 to 2.6 million over 30 years
- Water and energy subsidies

How to keep the next generation of farmers in business?

- Alter cropping systems to meet long-term demands and climate/water constraints
- Breed for emerging stresses and new crops
- Rebuild soil organic matter
- Transform groundwater policy: incentivize water use efficiency; monitor at basin scale; set regional or basin-wide caps
- Re-think trade relationships, e.g., Africa, India

Thank You