Adaptation in Agriculture

Snowmass CO

Will Adaptation Occur?

- Farm adaptation is in the interest of every farmer because they are sole beneficiary (private adaptation)
- Will happen even without public policy
- Will be efficient if:
  - No externalities
  - Private property (vs common property)
  - Access to markets

What are Farm Adaptations?

- Choose whether land should be farmed
- Choose type of farm (crop, livestock, mixed)
- Choose type of crop
- Choose type of livestock
- Choose timing (planting, harvesting)
- Choose inputs (fertilizer, labor, capital, irrigation)

Evidence of Adaptation?

- Studies in Asia, Africa, Latin America, Europe, and North America all reveal farmers adapt to current climate

Marginal Farmland Choice in United States

Season	Temperature	Precipitation
Winter	-.109	-.212
Spring	-.008	-.006
Summer	+.123	+.330
Fall	+.008	-.010

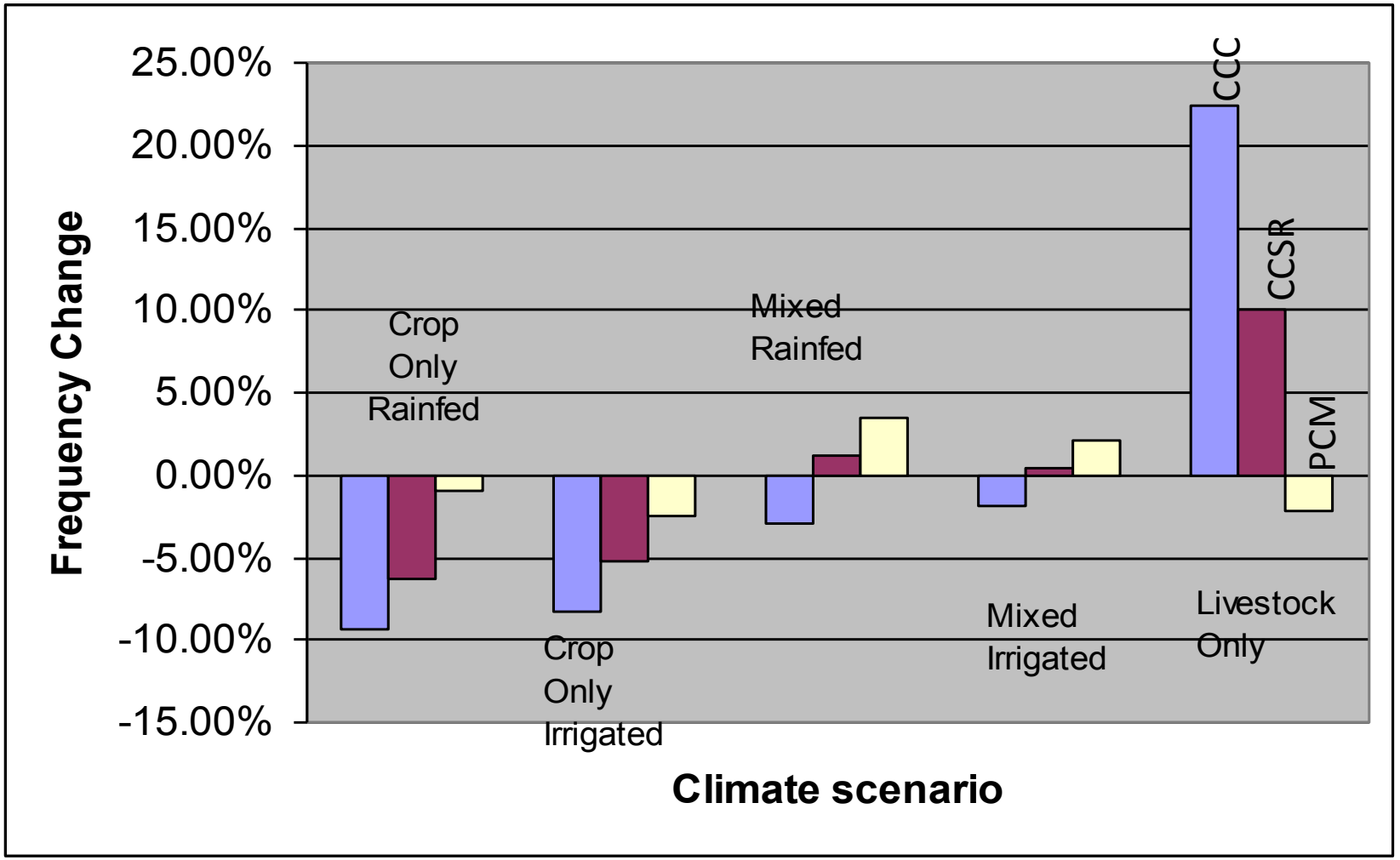
Marginal Temperature Effects on Crops and Livestock in United States

Season	Crop	Livestock
Winter	-.354	+.419
Spring	+.009	-.024
Summer	+.272	+.022
Fall	+.005	+.018

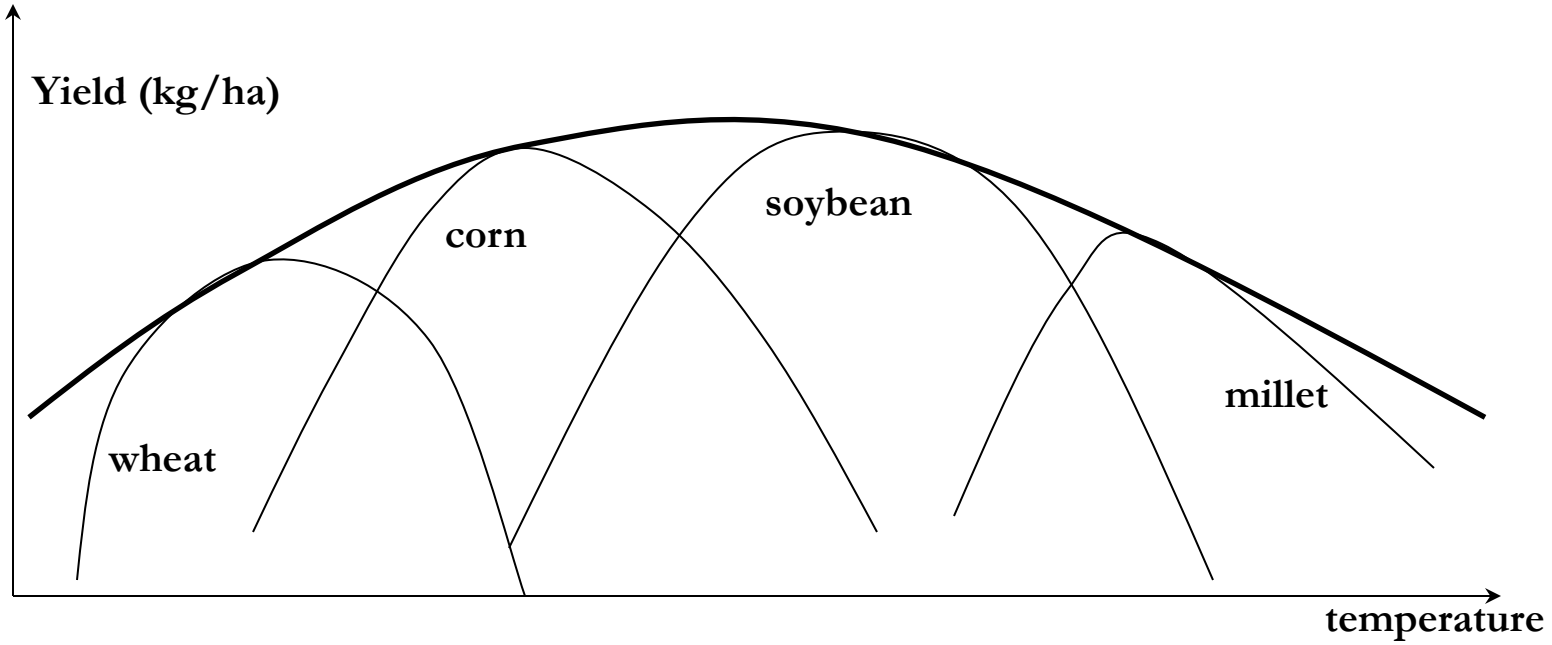
Marginal Precipitation Effects on Crop and Livestock in United States

Season	Crop	Livestock
Winter	-.375	+.295
Spring	+.008	-.020
Summer	+.398	-.680
Fall	-.022	+.023

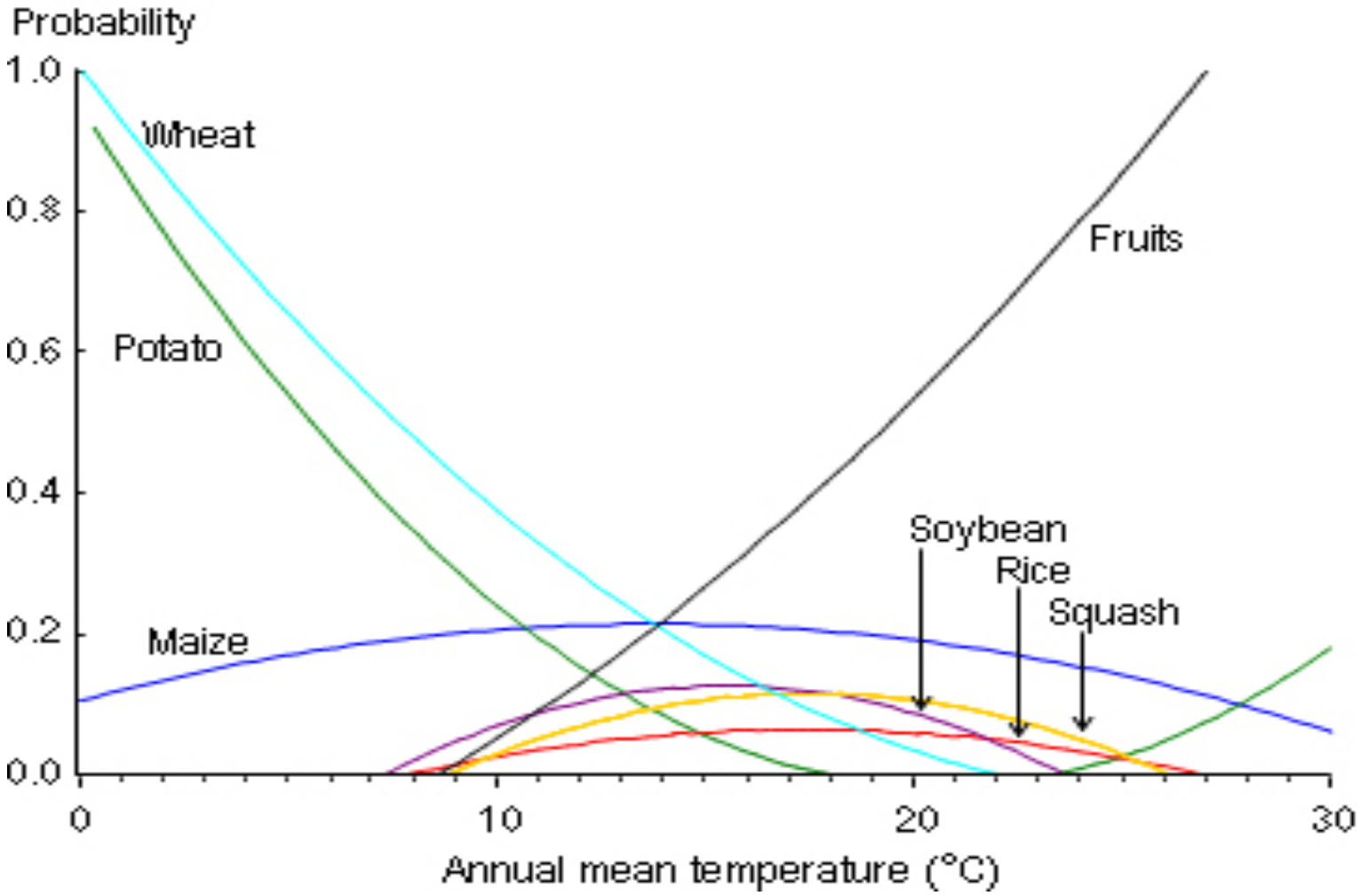
Nonmarginal Impact of Climate Change in 2100 on Farm Type in Latin America



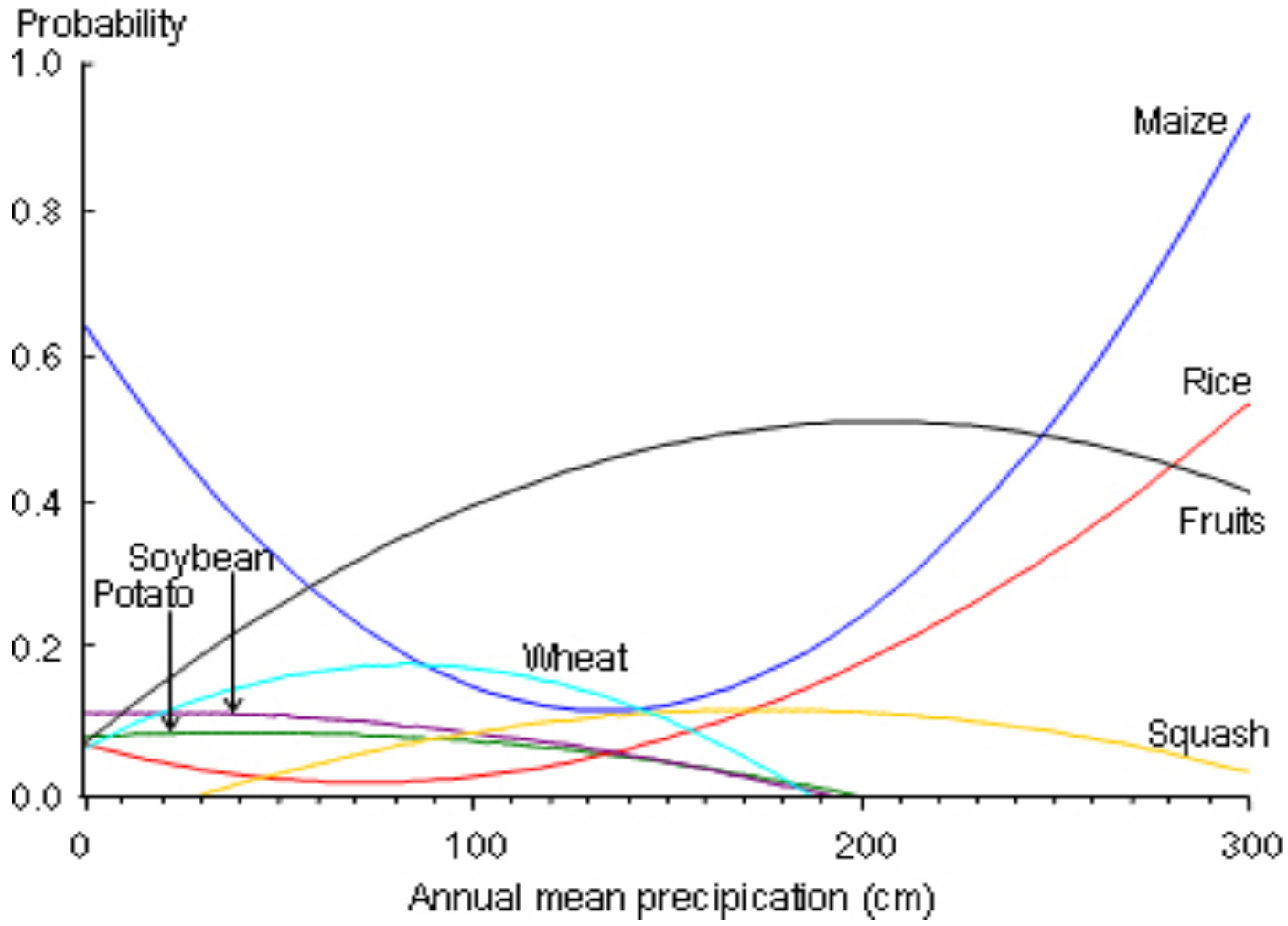
Crop Switching



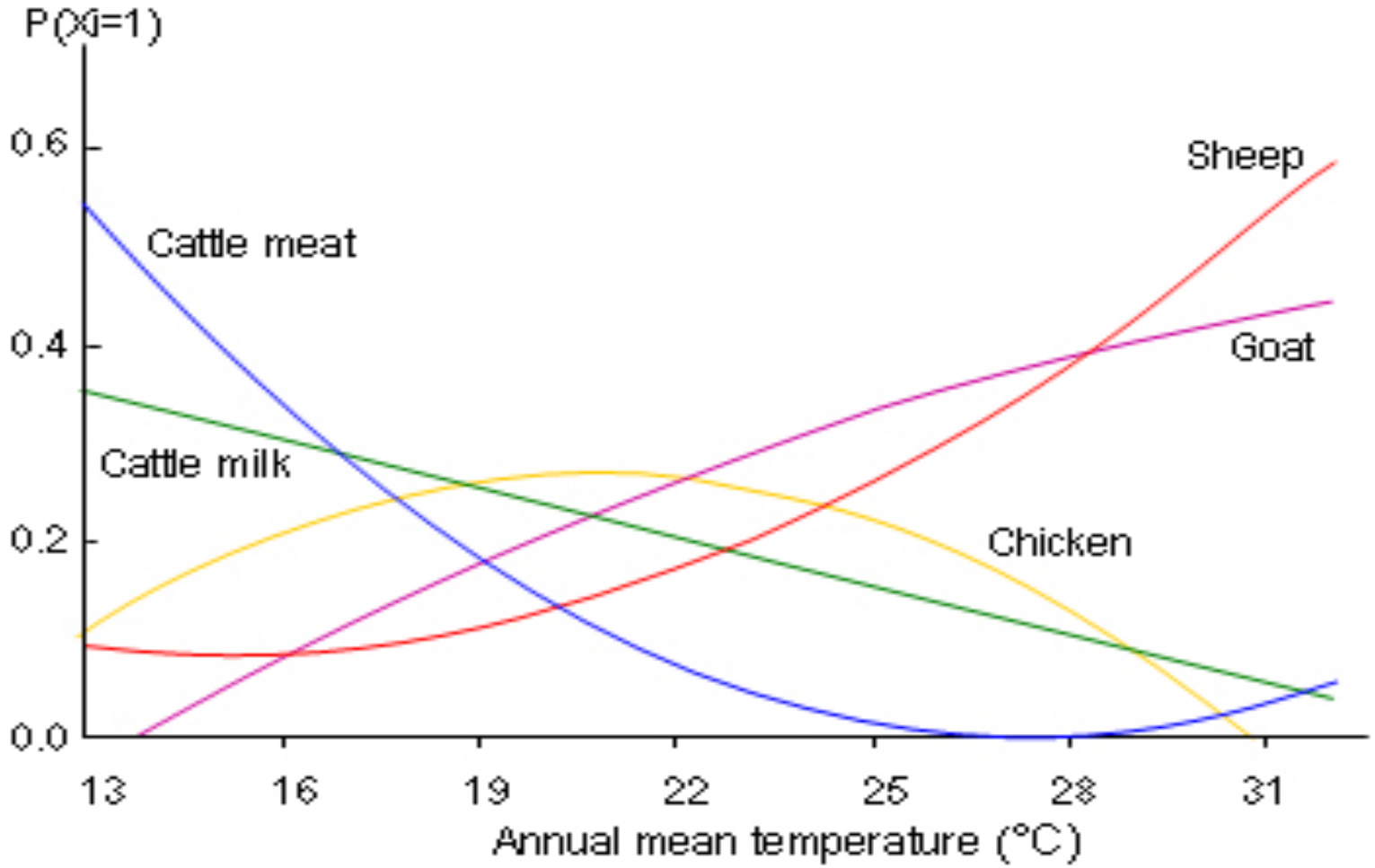
African Crops vs Temperature



African Crops vs Precipitation

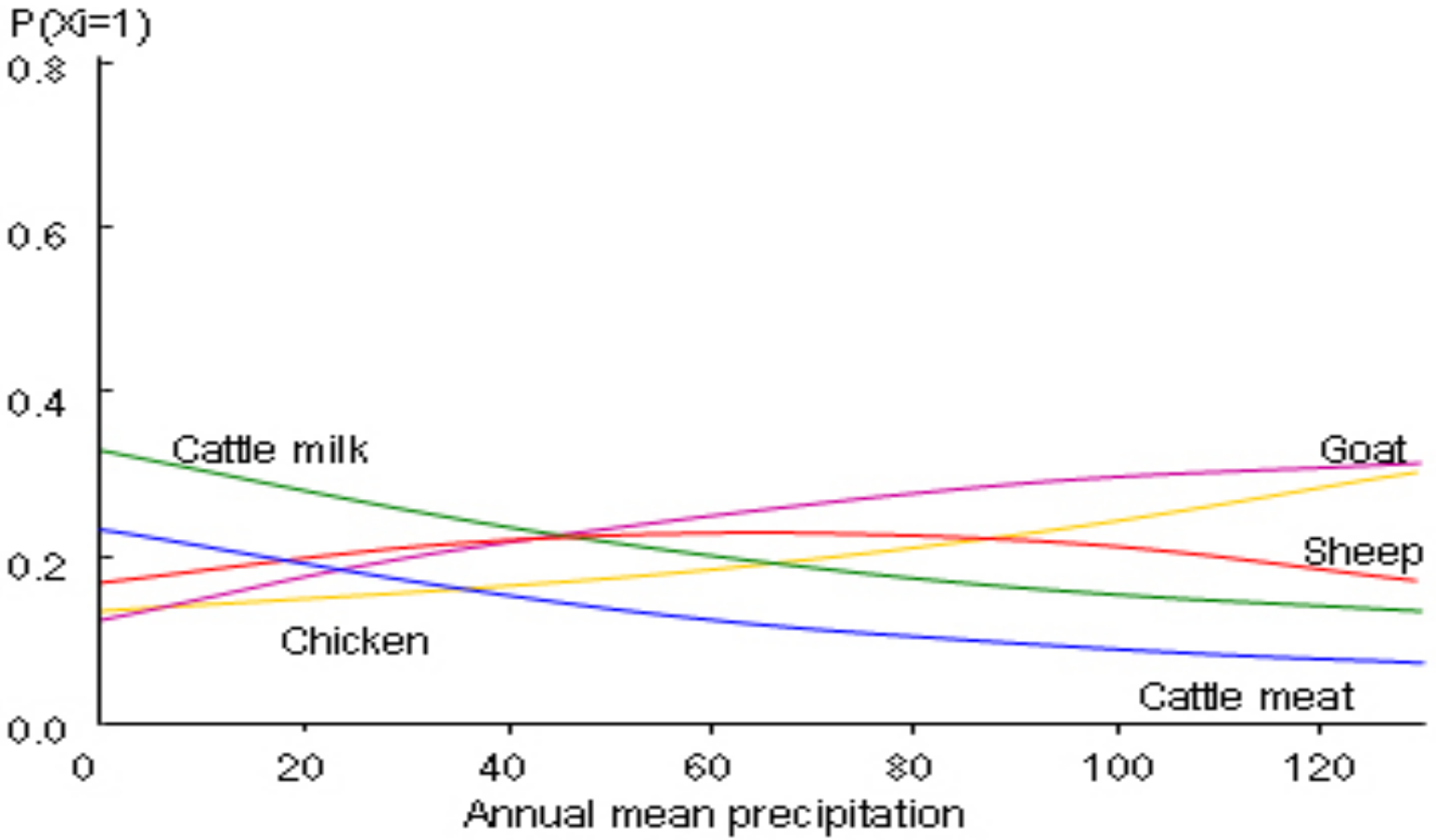


African Livestock vs Temperature



Mean temperature: Cattle meat=19; cattle milk=19; goat=24; sheep=24; chicken=21

African Livestock vs Precipitation



Mean precipitation: Cattle meat=58; cattle milk=63; goat=68; sheep=59; chicken=76

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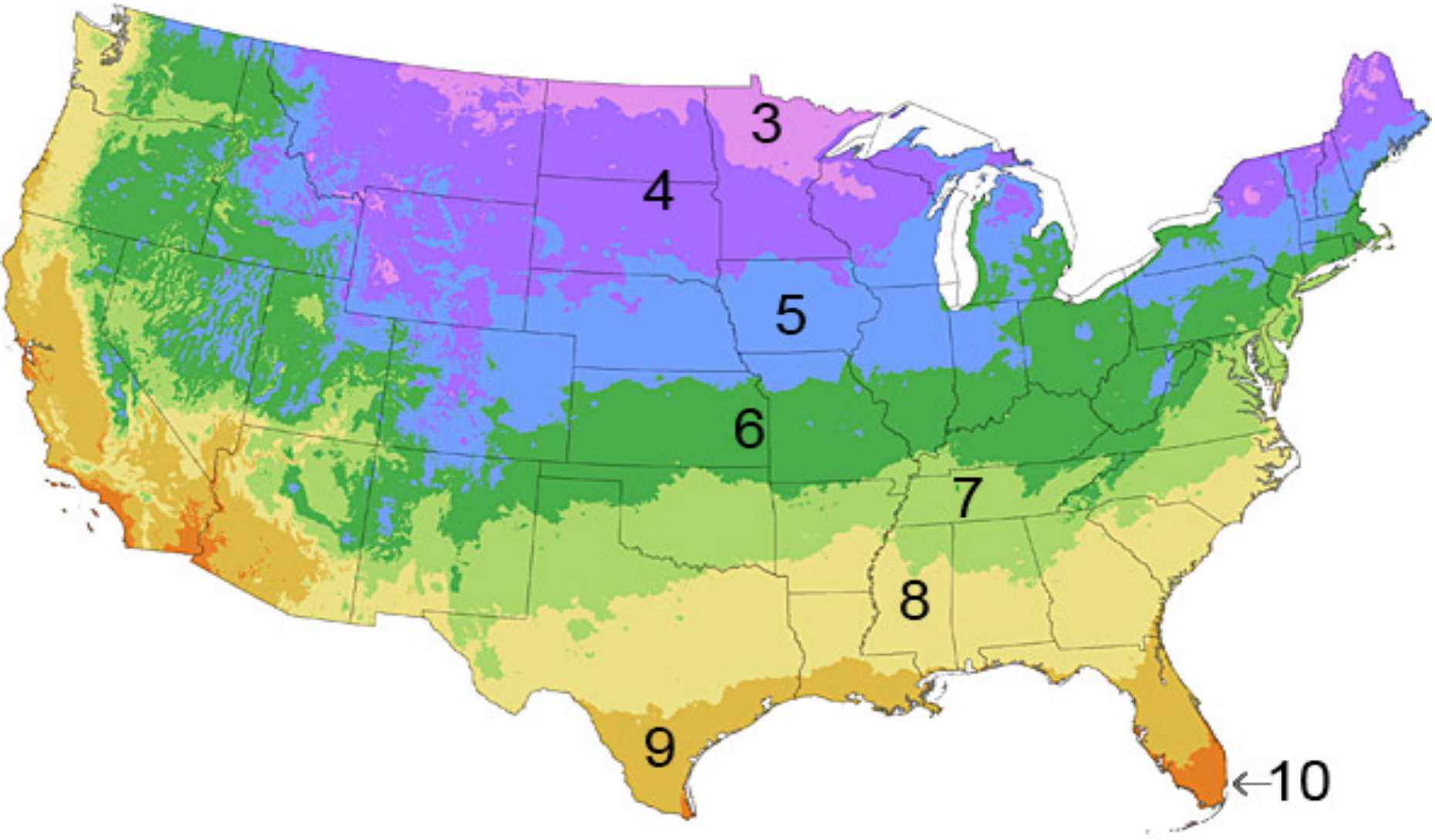
Planting Dates in US



Climate Marginal for Irrigation in Africa

	Selection Model (Irrigation Choice)		
	Temperature ·C	Precipitation mm/mo	**Flow million m^3/ mo**
Winter	0.26 (0.09)	-0.003 (0.01)	**-3.09 (1.1)**
Spring	-0.46 (0.09)	-0.01 (0.005)	**1.4 (1.29)**
Summer	0.08 (0.08)	0.01 (0.002)	**-0.6 (0.51)**
Fall	0.17 (0.09)	-0.00003 (0.002)	**0.77 (0.29)**
Annual	**0.06 (0.02)**	**-0.01 (0.01)**	**-1.54 (0.66)**

How does Adaptation alter Impacts in Agriculture?

- Efficient adaptation lowers net impacts (counting cost)
- With CO2 fertilization, climate change likely mildly beneficial to global agriculture up to $2^{o}C$ more than today
- Beneficial effects stronger in mid and high latitudes- possible damages in low latitudes

How does Adaptation alter Impacts in other Sectors?

- Adaptation lowers damages from extreme events by order of magnitude- damages in US to hurricanes is 20 times the rest of the world
- Adaptation lowers damage from sea level rise by order of magnitude- comparison of estimate from DICE versus FUND
- Adaptation lowers deaths by 2 orders of magnitude- comparison of potential versus likely deaths

New Damage Estimates

- Updating damages so that they include efficient adaptation lowers overall damage by an order of magnitude
- Long run temperature targets of $3^{o}C$ and $4^{o}C$ should be actively debated

Weakness of Analysis?

- Private adaptation on common property?
- Public adaptation (many beneficiaries)?
  - What will governments do?
  - Serve special interest groups like people on coasts?
  - Do efficient adaptation?