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Evaluating the Effects of Climate Change on US Agricultural Markets:
Sensitivity to Regional Impact and Trade Expansion Scenarios

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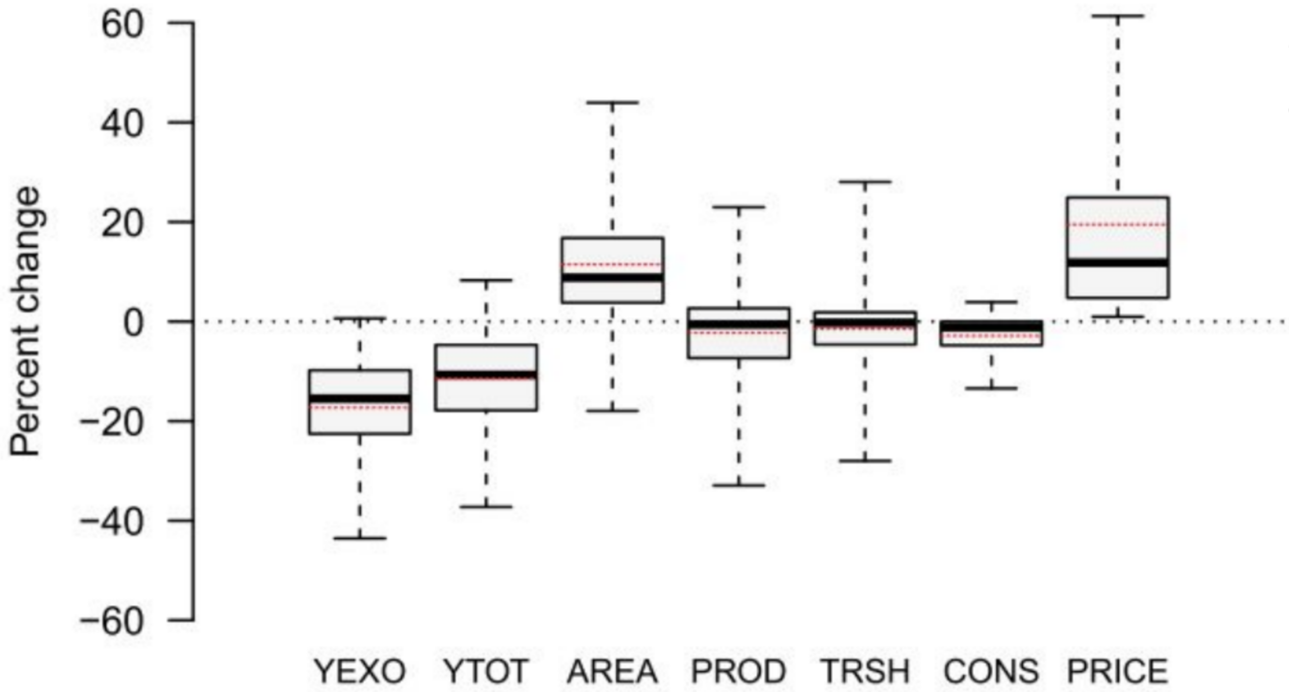
Climate change impact and trade

- There is an extensive literature that applies a wide variety of methods to project climate change damages in agriculture:
  - Supply-side simulation models or reduced-form econometrics,
  - National partial and general equilibrium models (CGEs)
  - Global CGEs and integrated assessment models (IAMs)

- Global analyses find that trade should play an important role in adaptation of agricultural markets to climate change

Adaptation channels

RCP 8.5 no-CO_2



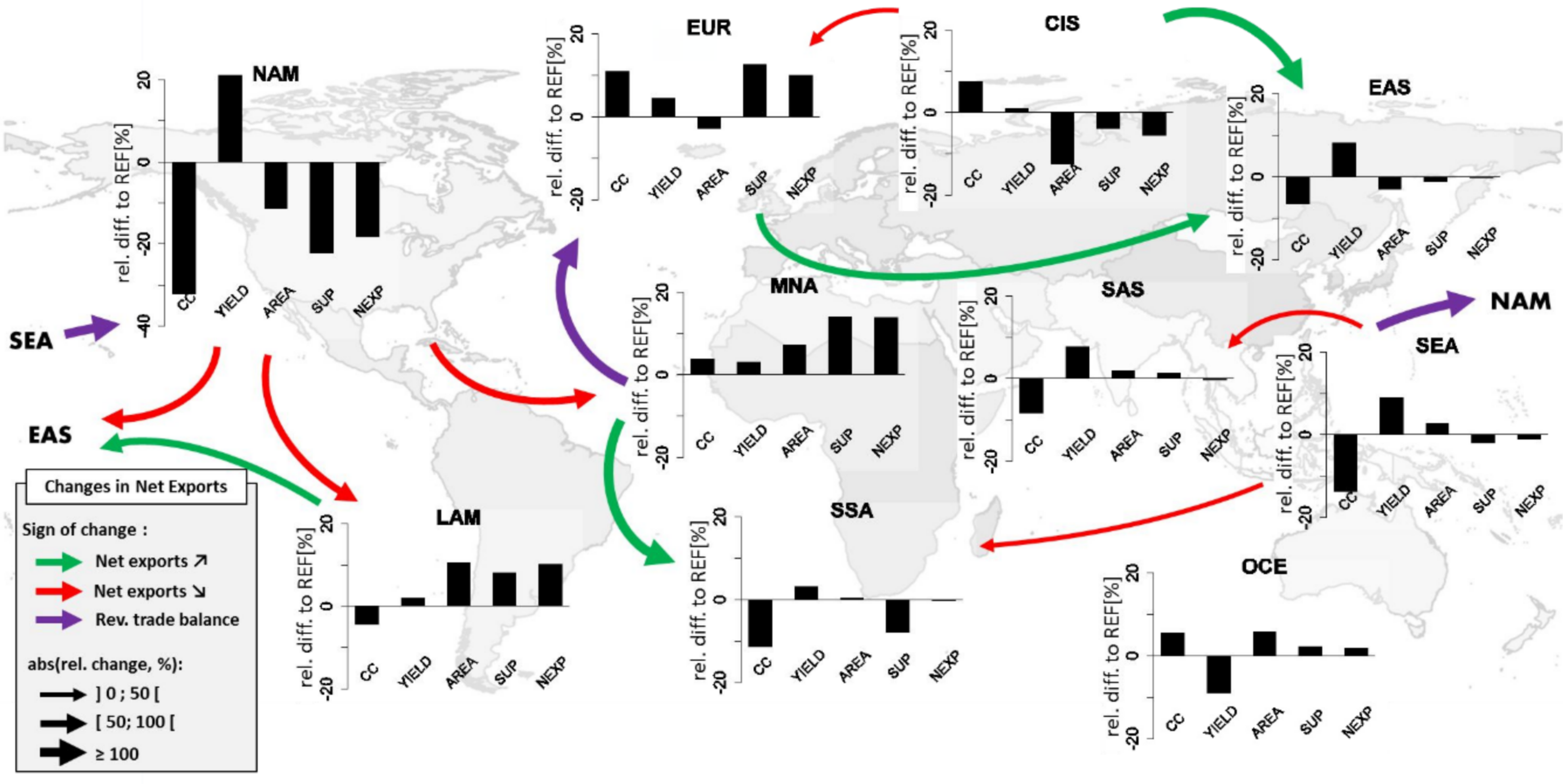
	YEXO	YTOT	AREA	PROD	TRSH	CONS	PRICE
n	2891	2891	2891	2891	2891	2891	2891
Mean	−0.17	−0.11	0.11	−0.02	−0.01	−0.03	0.2
SD	(0.13)	(0.17)	(0.25)	(0.25)	(0.26)	(0.06)	(0.24)

- YEXO– exogenous yield
- YILD– endogenous yield
- AREA– crop area
- PROD– total US production
- TRSH – trade as share of PROD
- CONS– total US consumption
- XPRP– prices

Source: Nelson, Valin et al., 2014, PNAS

How is EU impacted compared to RoW?

(HadGEM2-ES – RCP8.5 with CO_2 – 2050)



Source: Leclère et al., ERL, 2014

Climate change from a national perspective

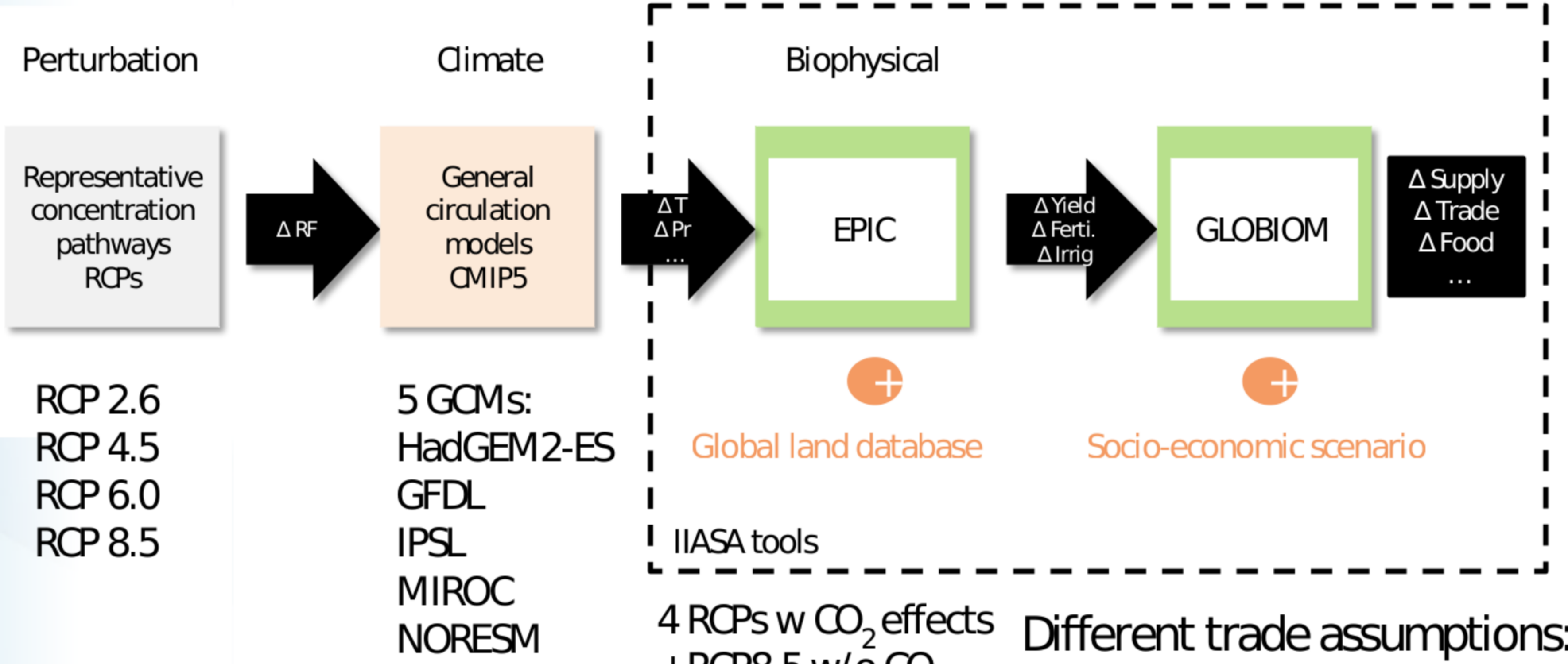
- Many regional analyses also feature trade
  - May ignore potential climate change and systemic productivity shifts in other countries

- How much does climate change impact in the rest of the world matter?

- Focus on the United States: two scenarios are compared
  1. Impacts of climate change on the US only (domestic study set-up)
  2. Impact of climate change in all regions of the world

- Different trade flexibility assumptions are explored

The impact assessment modeling framework

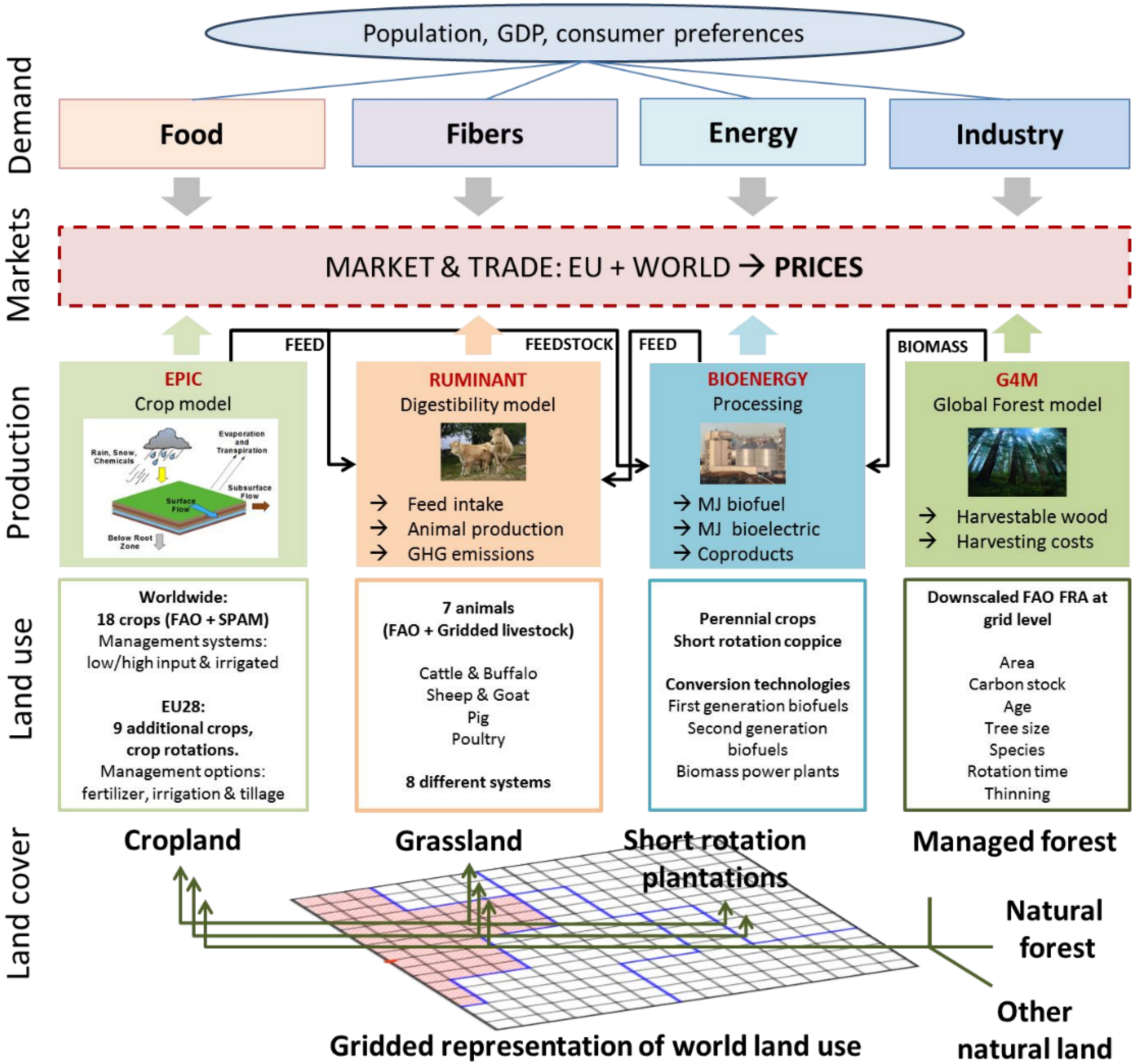


4 RCPs w CO_2 effects
+RCP8.5 w/o CO_2 effects

Different trade assumptions:

T0 – default assumptions on trade policies/costs

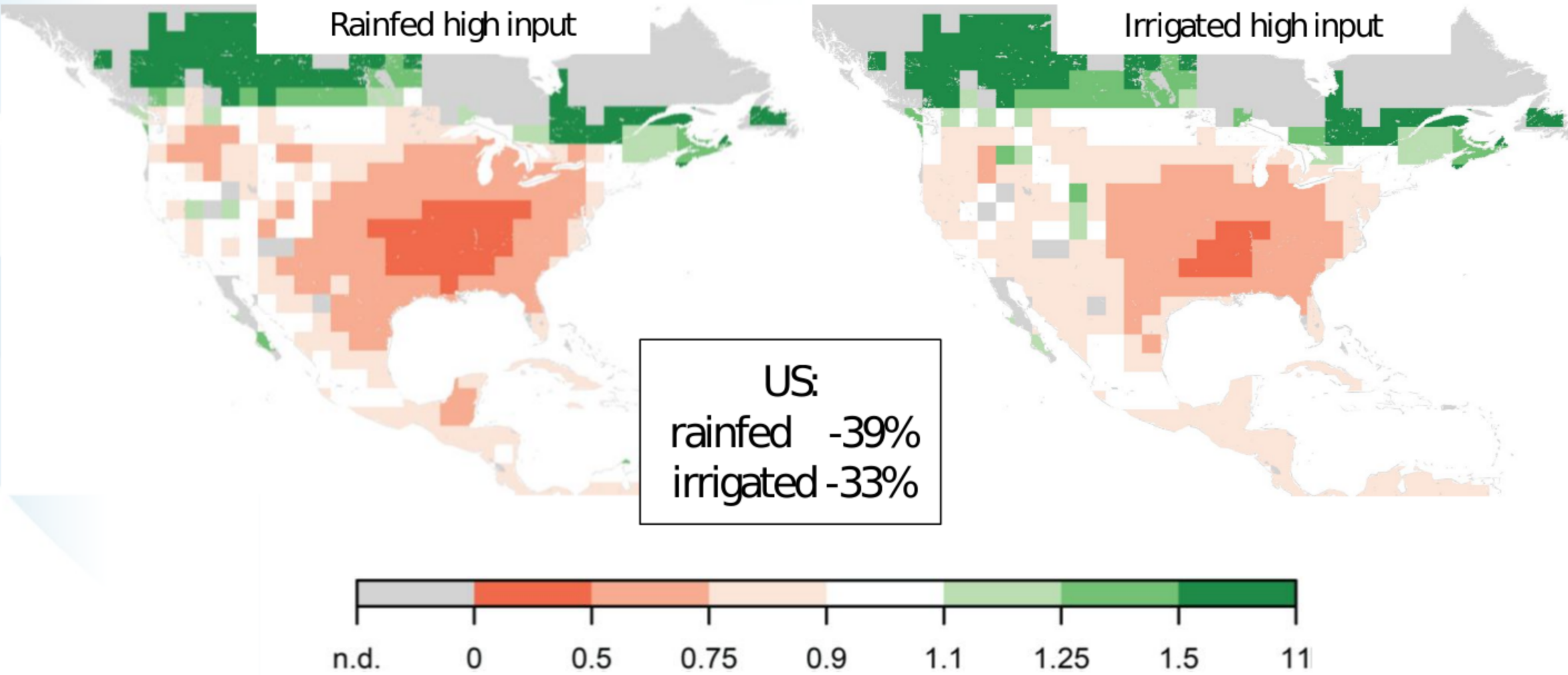
T2 – rapidly globalized markets


Population, GDP, consumer preferences
Demand
Food
Fibers
Energy
Industry
Markets
MARKET & TRADE: EU + WORLD → PRICES
FEED
FEEDSTOCK
FEED
BIOMASS
Production
EPIC
Crop model
RUMINANT
Digestibility model
→ Feed intake
→ Animal production
→ GHG emissions
BIOENERGY
Processing
→ MJ biofuel
→ MJ bioelectric
→ Coproducts
G4M
Global Forest model
→ Harvestable wood
→ Harvesting costs
Land use
Worldwide:
18 crops (FAO + SPAM)
Management systems:
low/high input & irrigated
EU28:
9 additional crops,
crop rotations.
Management options:
fertilizer, irrigation & tillage
7 animals
(FAO + Gridded livestock)
Cattle & Buffalo
Sheep & Goat
Pig
Poultry
8 different systems
Perennial crops
Short rotation coppice
Conversion technologies
First generation biofuels
Second generation biofuels
Biomass power plants
Downscaled FAO FRA at grid level
Area
Carbon stock
Age
Tree size
Species
Rotation time
Thinning
Land cover
Cropland
Grassland
Short rotation plantations
Managed forest
Natural forest
Other natural land
Gridded representation of world land use

Global EPIC Corn Yield Impacts (AgMIP/ISIMIP Archives)

%change in corn yield [2050]

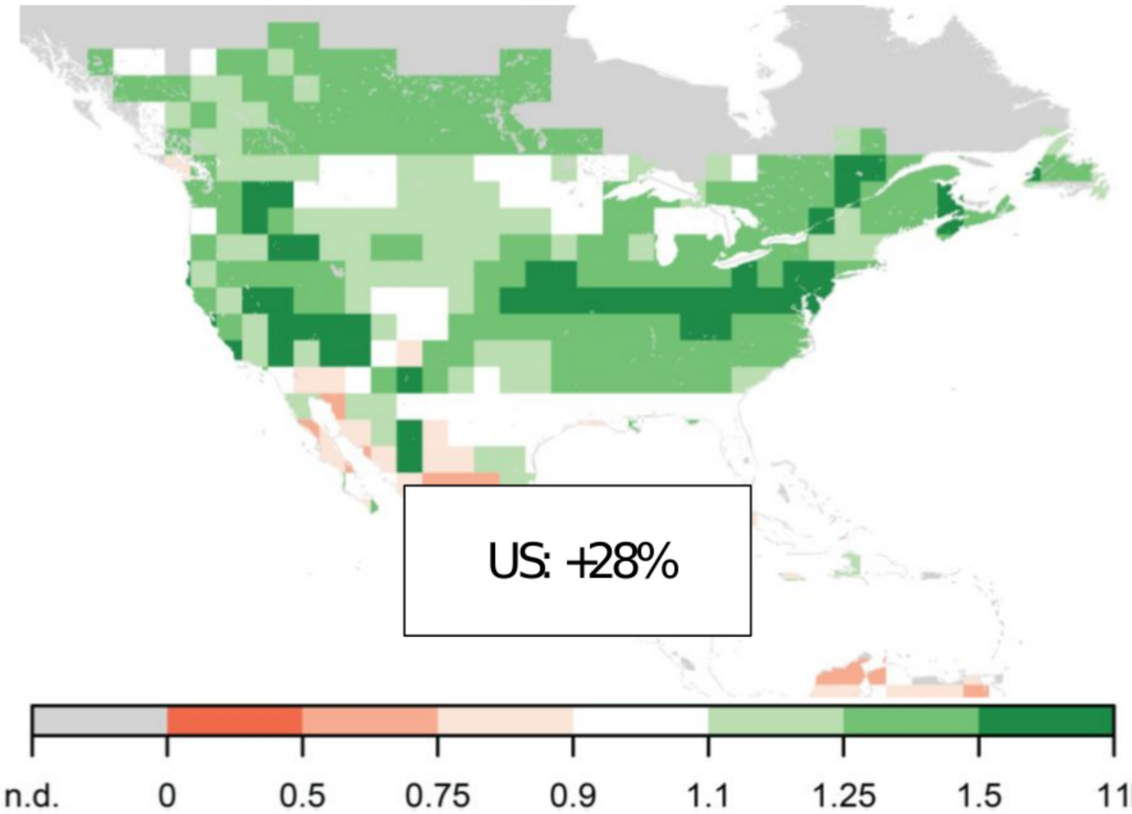
EPIC for RCP 8.5, HadGEM2-ES



Global EPIC Grass Yield Impacts (AgMIP/ISIMIP Archives)

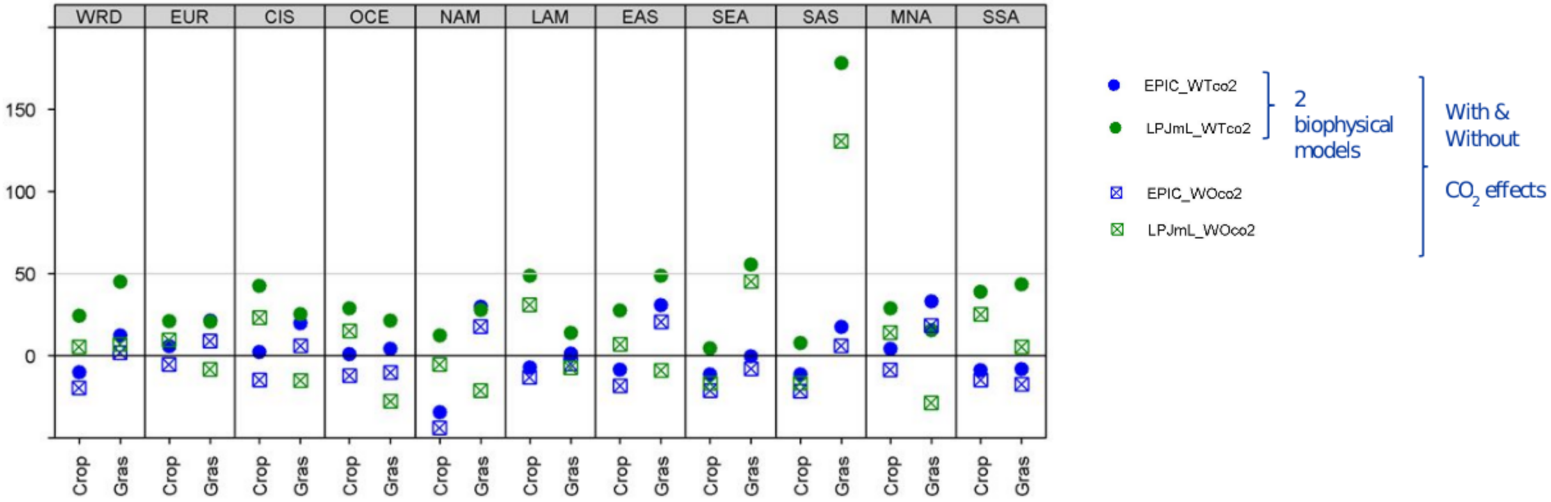
%change in grass yield [2050]

EPIC for RCP 8.5, HadGEM2-ES



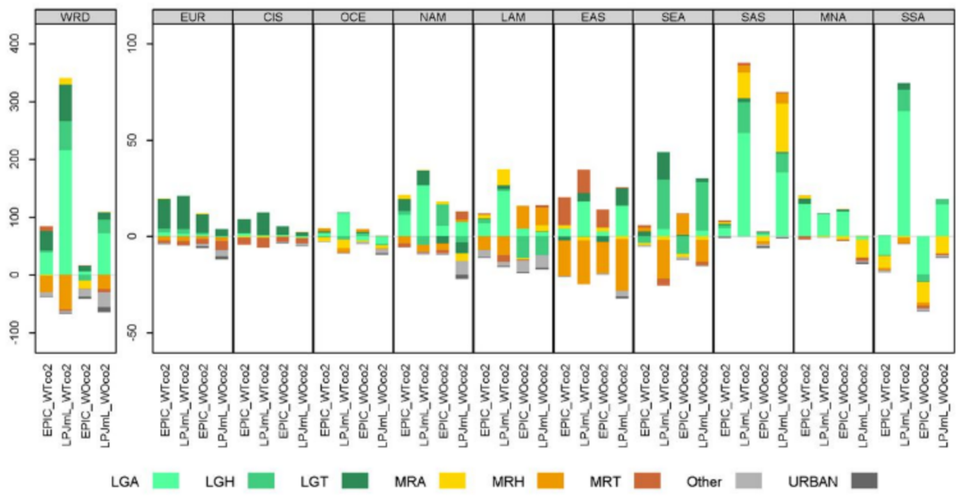
Livestock adaptation

Climate change impacts crops x grass: 2050



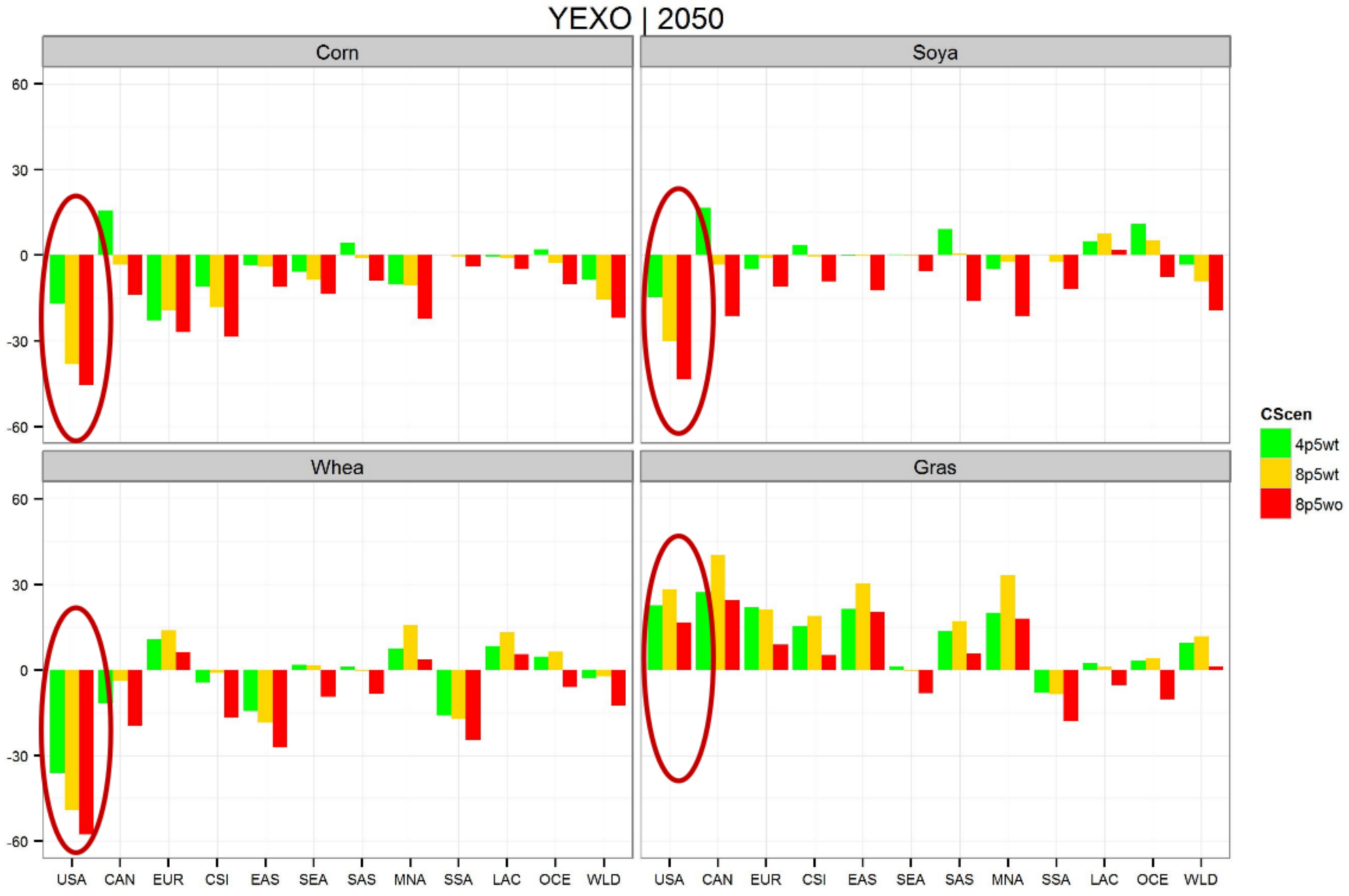
Source: Havlík et al. 2015, FAO

Change in ruminants by livestock productions system: 2050



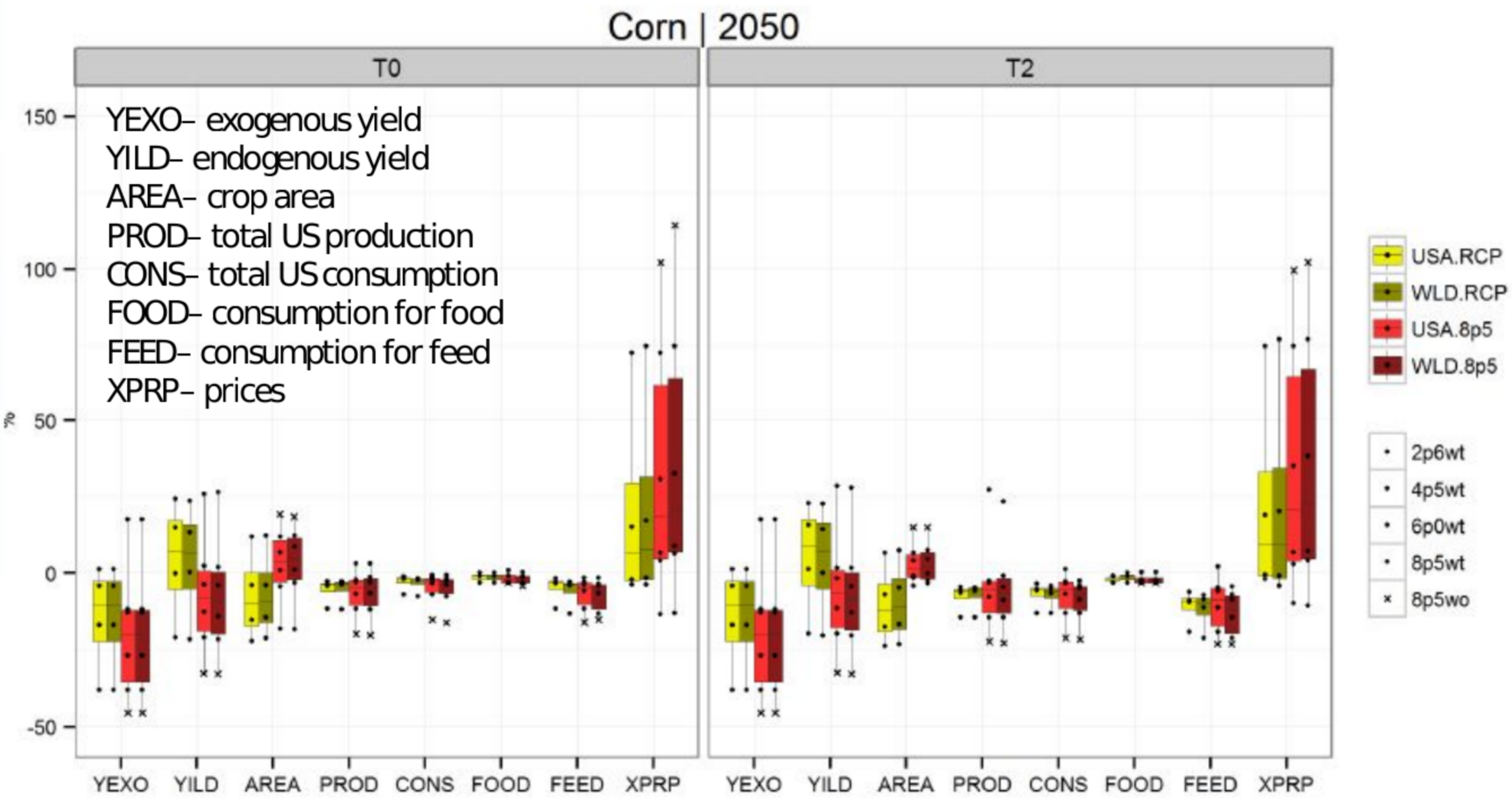
Climate change impacts on yields

- Major US crops relatively more affected than in other regions
- US grasslands favored by climate change



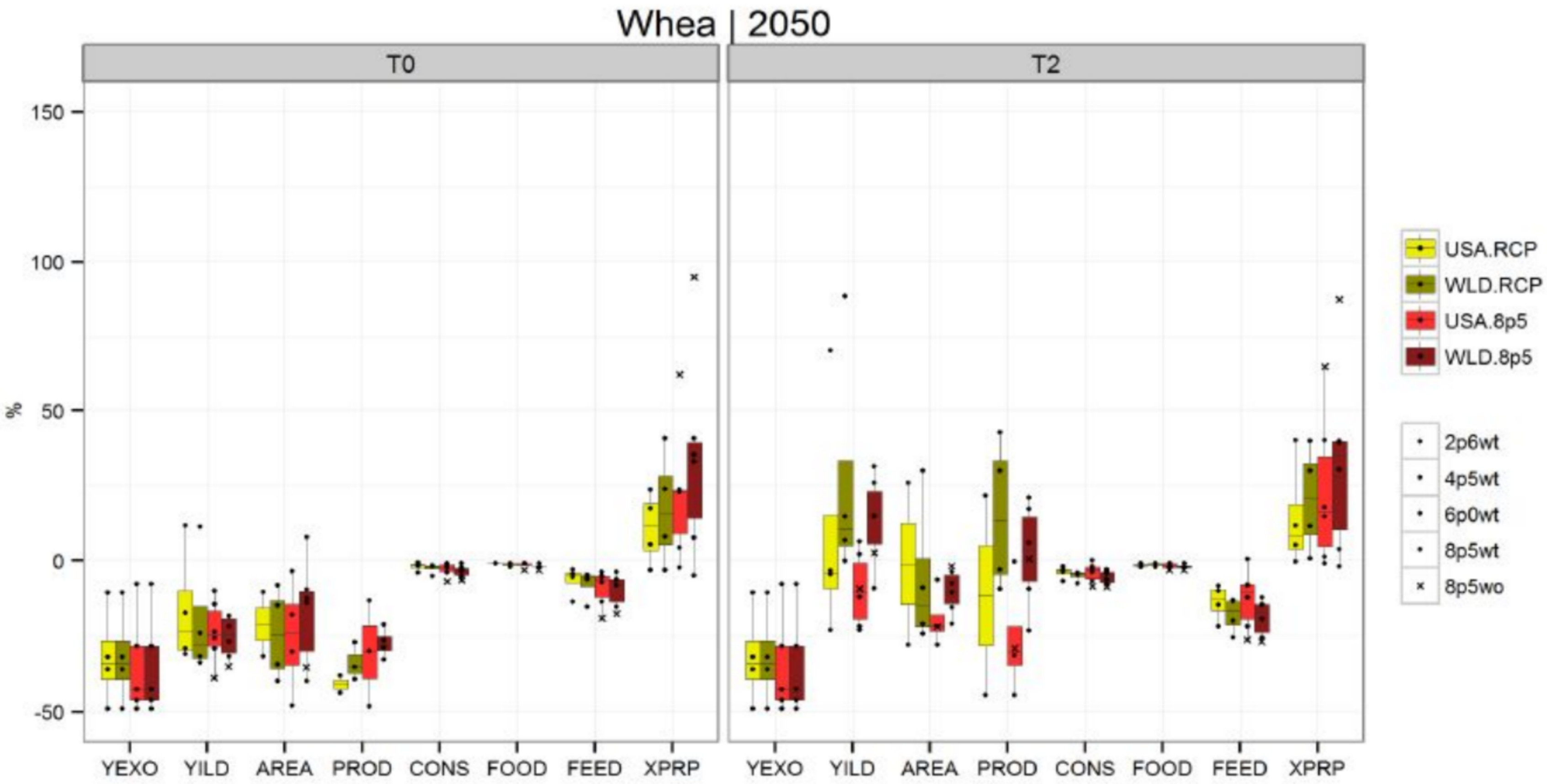
Results– U.S. corn production and markets

- Corn sees slight variability across zone of impact and trade scenarios
- Results are similar for soybean systems



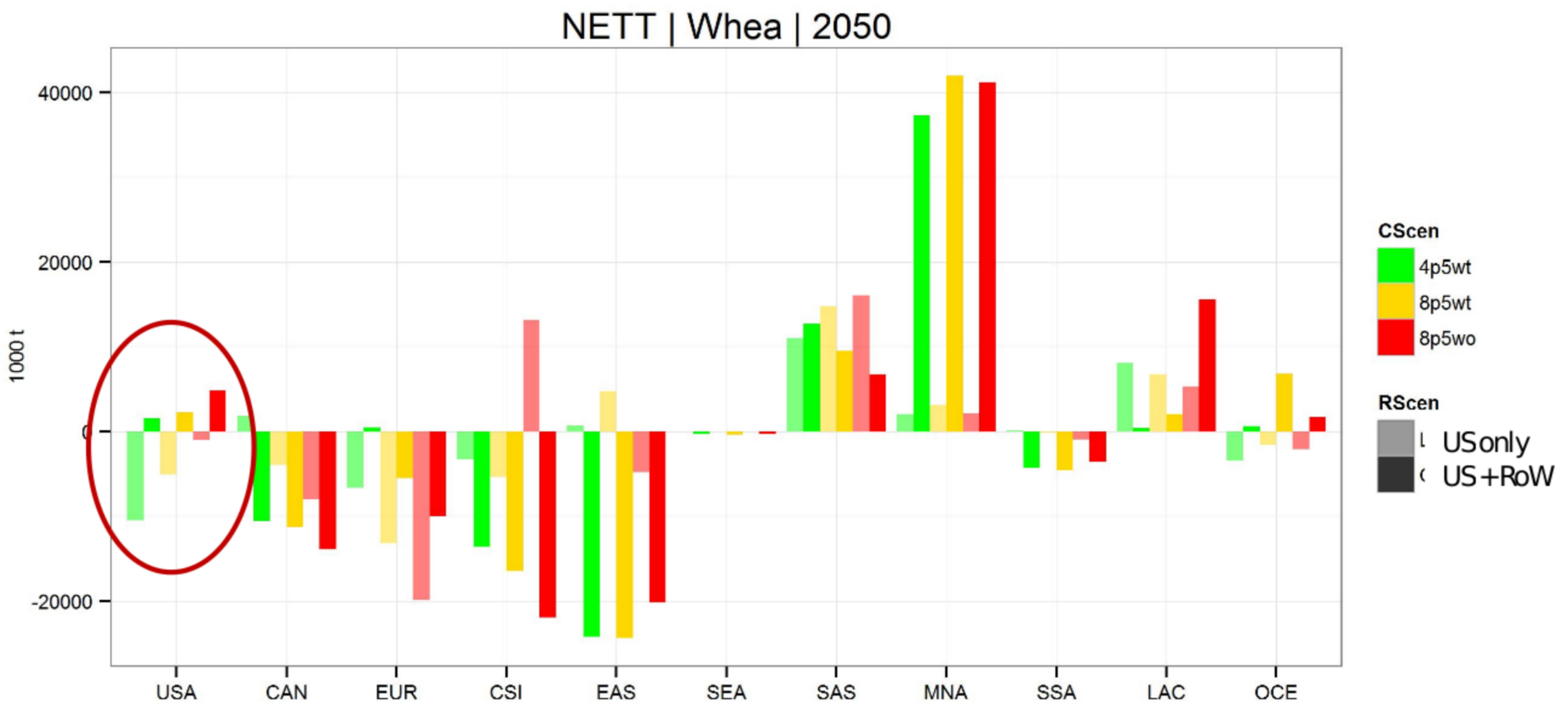
Results– U.S. wheat production and impacts

- Greater variability in projected wheat impacts across zone of impact and trade scenarios



Net trade change: Wheat

- US export less if only direct impacts taken into account
- US export more if indirect effects added



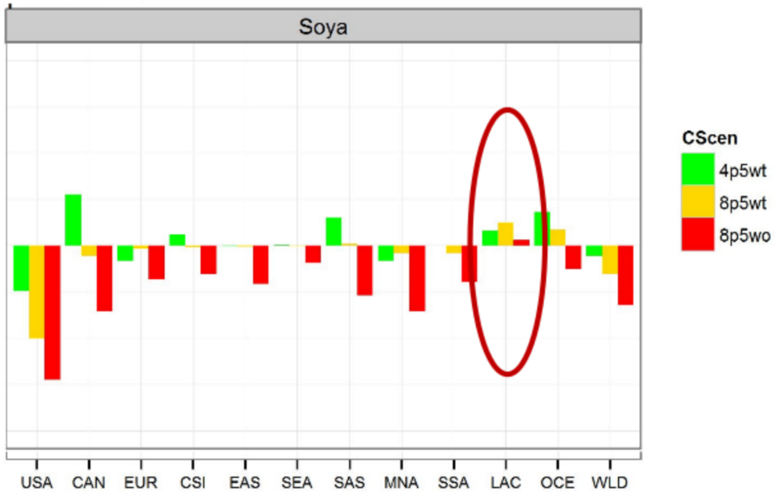
Why different impacts?

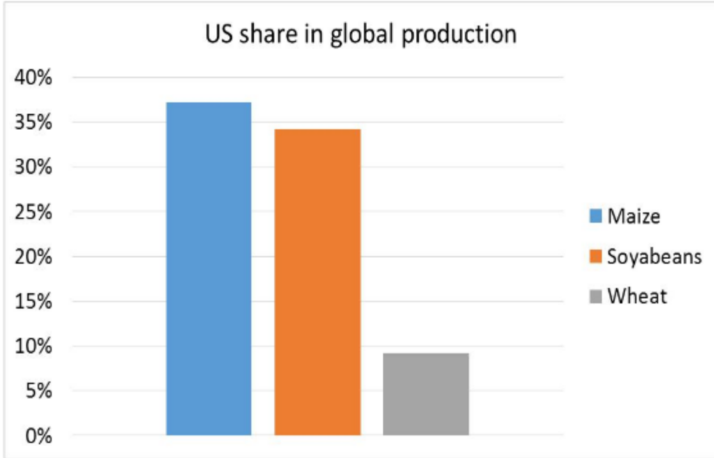
- How much of production is outside of the US?

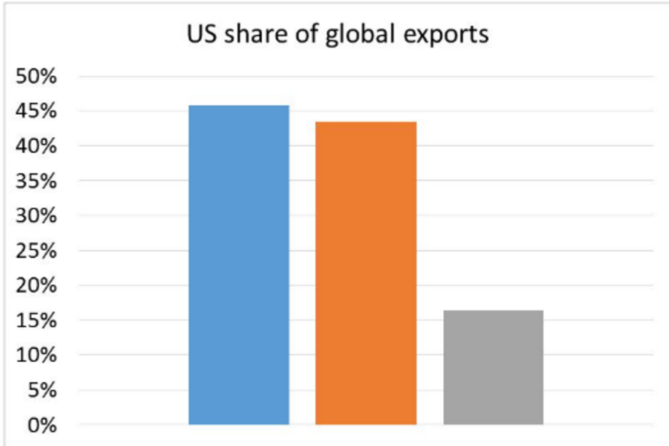
(CC impact missed with the national analysis)

- What are the direction of CC impacts outside of the US?

Yield change 2050 RCP8.5 (HadGEM2-ES +EPIC)

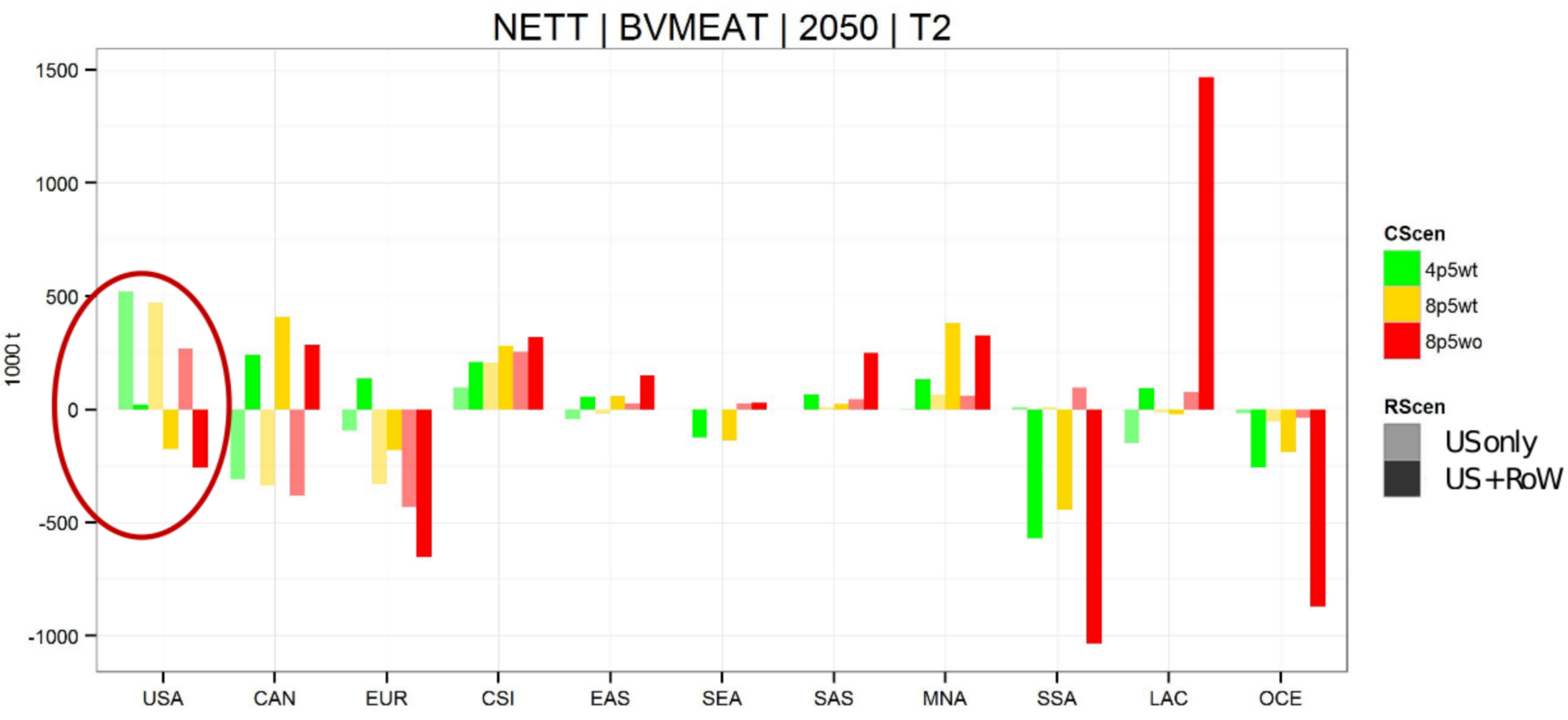




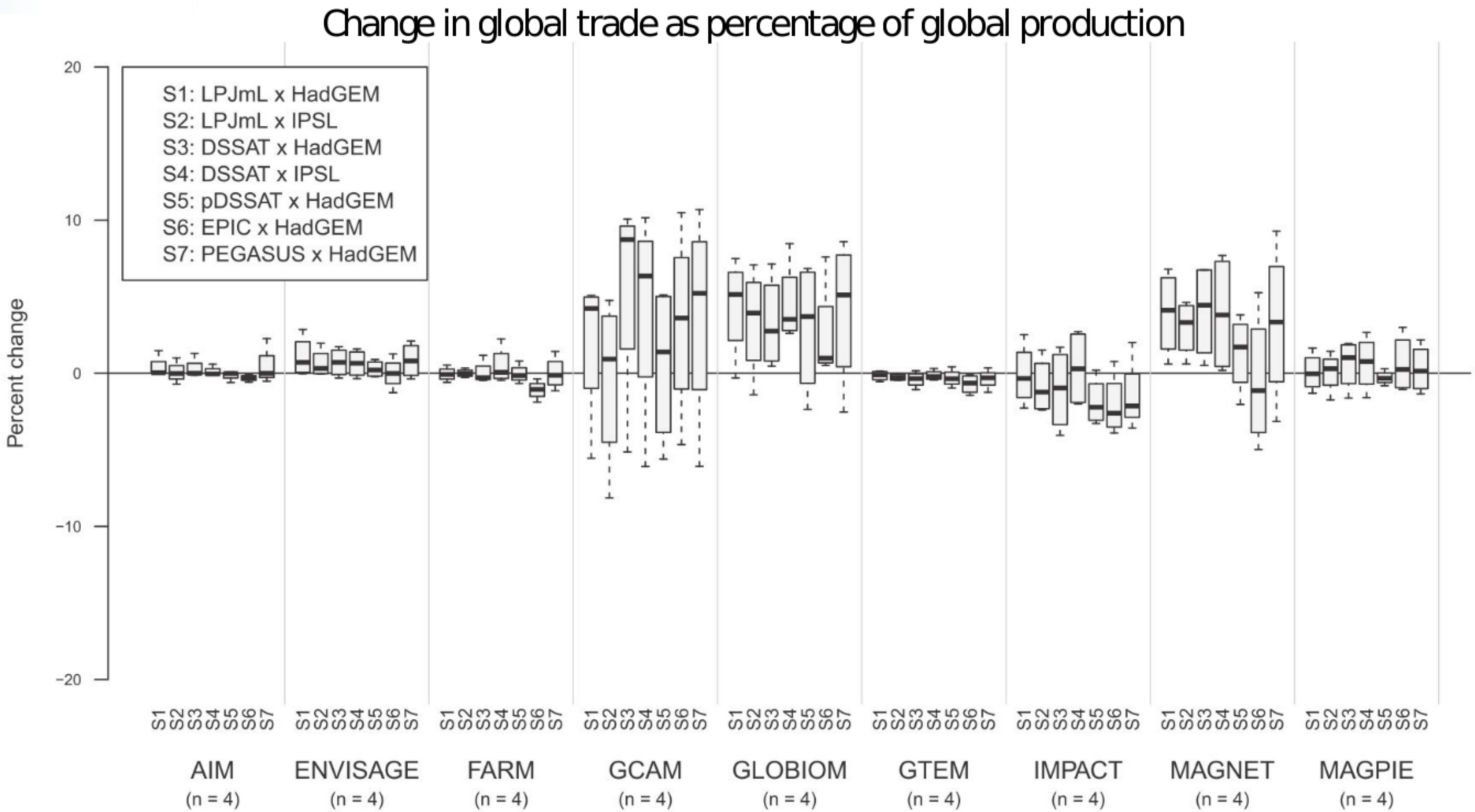


Net trade change: Beef

- US imports less if only direct impacts taken into account
- US imports more if indirect effects added



Trade sensitivity varies across models



Source: Nelson, Valin et al., 2014, PNAS

Conclusions

- US agricultural sector impacts are likely to be significant
  - Notable variation in magnitude across RCPs and GCMs
- Trade can be an important channel to buffer impact of climate change
  - Regional analysis may significantly over- or underestimate trade response magnitude and even directions
    - Global market representation remains key
- Models disagree on trade potential contribution
  - More empirical and econometric to mobilize
  - More micro-level analysis (infrastructure, trade restrictiveness) to support large scale analysis

Thank you !

Questions…

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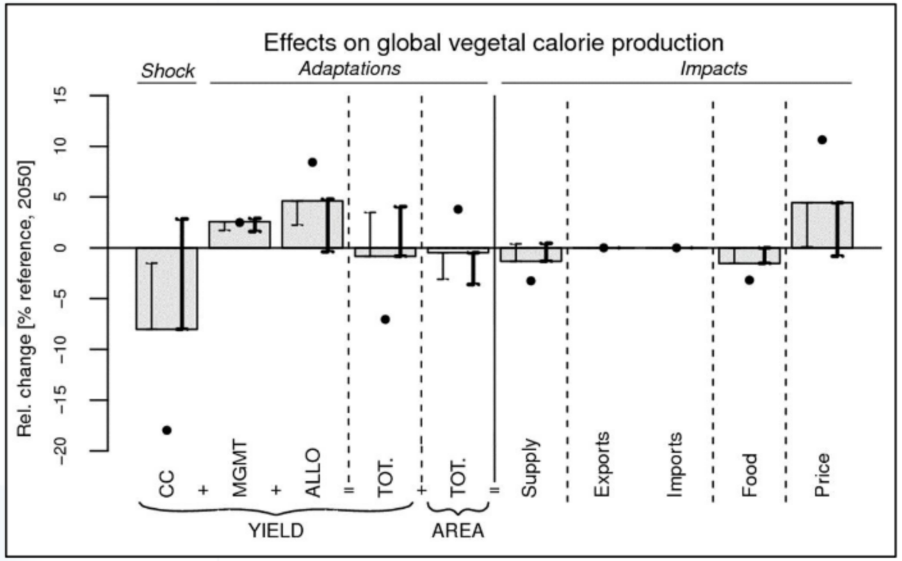
Comparing Projected Impacts across Commodity Groups

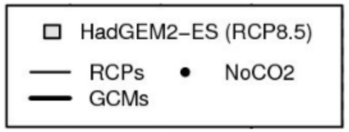
Price Impacts				
Trade	Base Trade		Expanded Trade	
Zone of Impact	USA	WLD	USA	WLD
Barley	25.5%	28.5%	28.3%	31.5%
Corn	23.6%	26.2%	25.1%	25.9%
Cotton	49.8%	67.8%	45.8%	54.7%
Rice	2.4%	3.1%	1.0%	1.6%
Soybeans	27.8%	30.3%	29.0%	30.8%
Sorghum	40.3%	52.7%	31.7%	46.4%
Wheat	17.1%	26.2%	17.2%	26.8%

Comparing Projected Impacts across Commodity Groups

Production Impacts				
Trade	Base Trade		Expanded Trade	
Zone of Impact	USA	WLD	USA	WLD
Barley	–11.5%	–9.9%	–25.7%	–19.5%
Corn	–5.6%	–5.5%	–4.4%	–4.9%
Cotton	–59.7%	–53.6%	–59.4%	–53.1%
Rice	–63.9%	–61.3%	–76.1%	–73.4%
Soybeans	–18.5%	–18.8%	–14.6%	–16.8%
Sorghum	–28.9%	–22.0%	–37.4%	–31.3%
Wheat	–48.3%	–36.4%	–36.1%	9.1%

Crop sector adaptation





Source: Leclère et al. 2014, ERL