

# SDWG – THESIS and Applied Projects

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# SDWG THESIS Computing Project

The Toolbox for Human-Earth System Integration and Scaling (THESIS) is developing models and software tools that allow for linkages between CESM and integrated assessment or impact models.

THESIS tools are used to assess the combined impacts of socio-economic development pathways and climate change in the three key areas of **cities, agriculture, and forests**.

To support the development and use of THESIS we requested computer time to perform idealized global land surface simulations of urban, agricultural and forest landscapes to evaluate climate change impacts in a **historical baseline, RCP4.5, and RCP 8.5** transient climate.

This is being expanded to include **CESM 1.5 and 2.0 degree simulations**

# SDWG THESIS Computing Project

Ongoing work:

1. Utilizing the new CESM 1.5 and 2.0 Degree transient simulations to extend the CLM Crop idealized simulations as were performed for the RCP 4.5 and RCP 8.5 BRACE study.

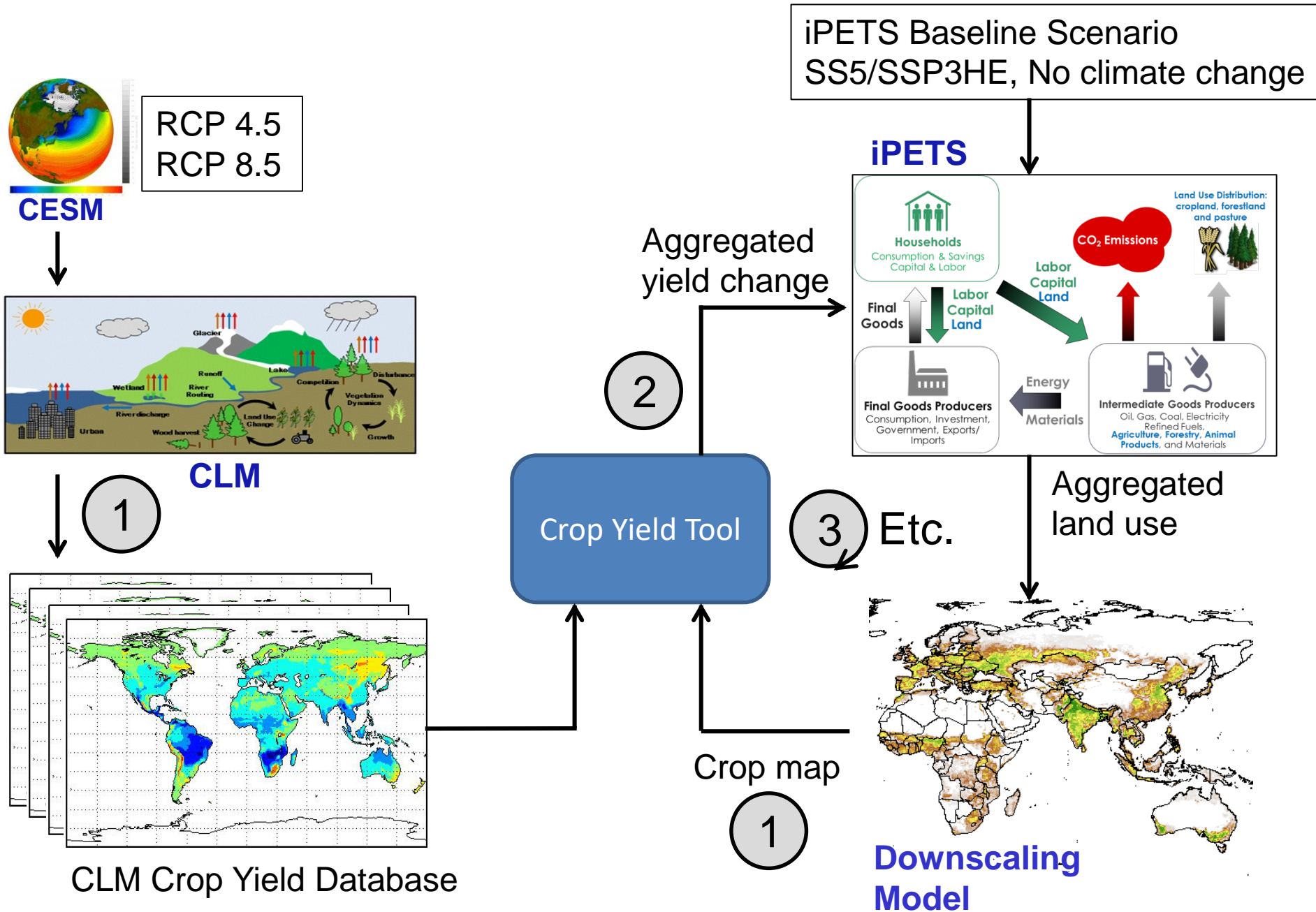
2. CLM Crop in the Agricultural Model Intercomparison and Improvement Project - AgMIP

GGCMI - Global Gridded Crop Model Intercomparison Project  
Phase 2: Analysis of model response to changes in Carbon (CO<sub>2</sub>),  
Temperature, Water and Nitrogen (CTWN) (Yaqiong)

3. RCP 4.5 climate forcing for ISAM crop simulations to continue the CLM Crop BRACE study to compare with the ISAM model

4. CLM Urban simulations looking at the impact of alternative Urban configurations under RCP 4.5 and RCP 8.5 (Bas and Jing)

# THESIS Agricultural Demand iPETS to CESM Crop Yield

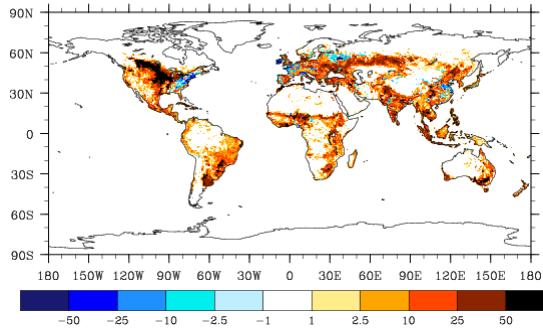


# Historical and RCP Global Crop Simulation Database

Crop Area time series from THESIS Downscale

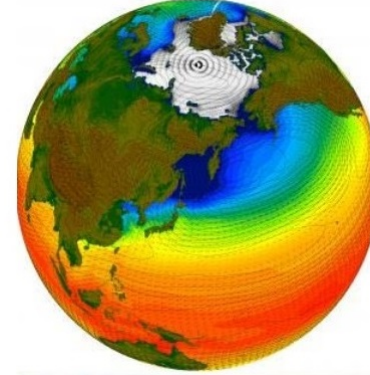
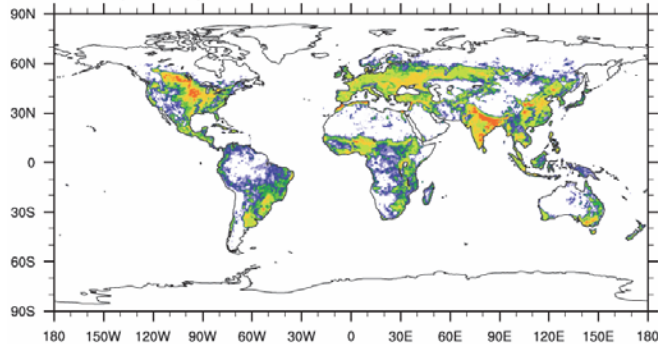
CESM Climate / CO<sub>2</sub> Scenario – Hist/RCP4.5/RCP8.5

(a) Historical (2005-1850) Crop PFTs



MIRCA 2000 Crop Type / Irrigation

CLM Crop - All Crops - 2012

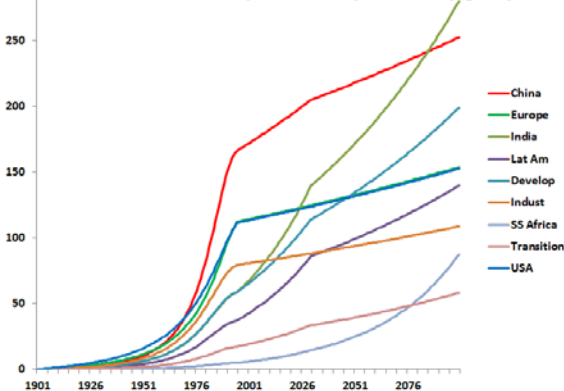


All Crops grown in every vegetated grid cell

Global CLM Crop Simulation Database

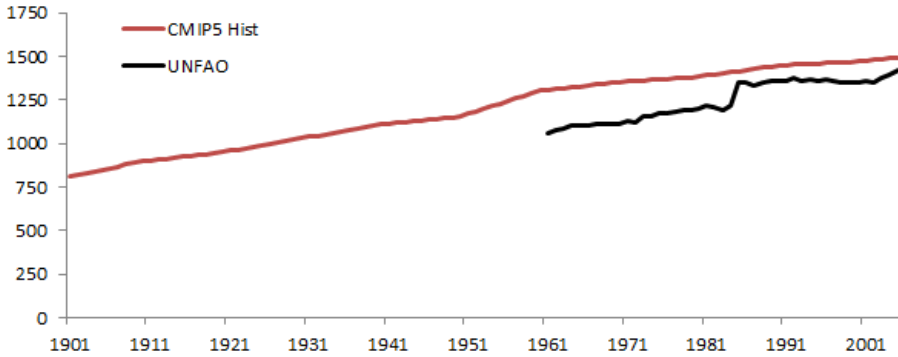
- Scenario
- Yield
- Temp.
- Crop
- Fertilizer
- Precip.
- Year
- Irrigation
- Solar
- Area
- CO<sub>2</sub>

UN FAO N Fertilizer (1995 - 2050) extented (kg/ha)

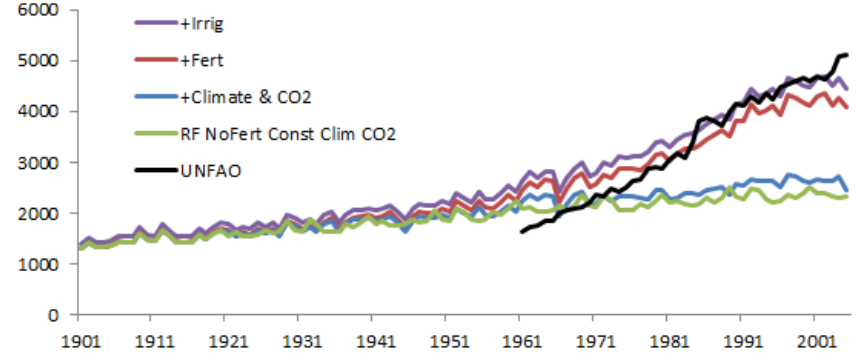


# Global Historical Analysis UNFAO Area, Yields, N Fert

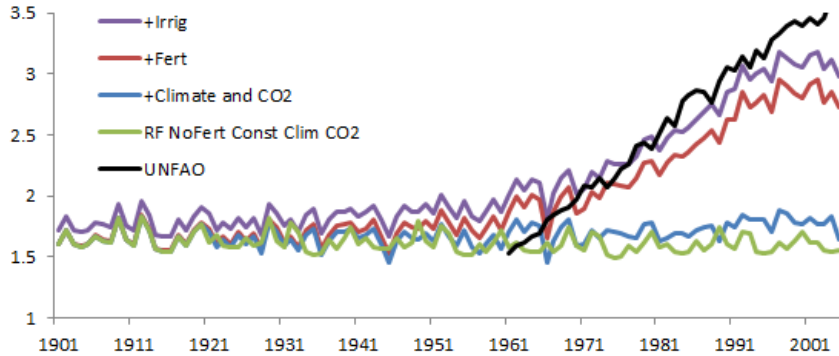
## Historical Global Crop Area (millions hectares)



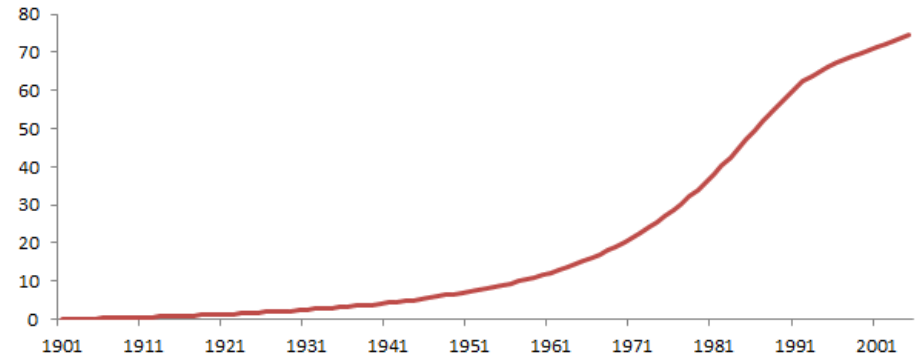
## Historical Global Production (millions tonnes)



## Historical Global Crop Yield (tonnes/ha)



## Historical Global N Fertilizer (kilograms/ha)

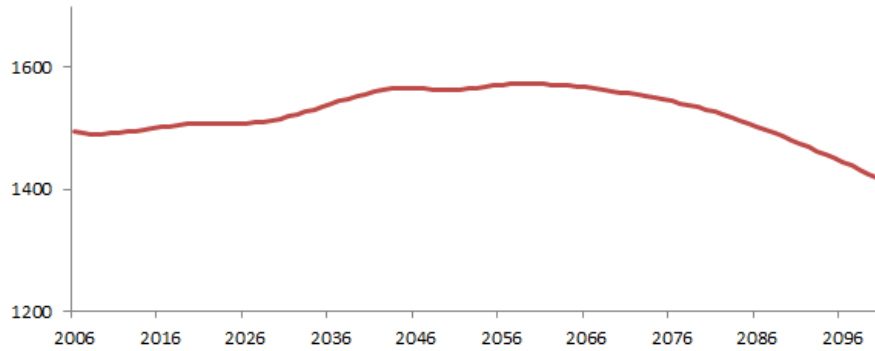


Area Effect	Climate & CO2	N Fert Effect	Irrig Effect	Total Effect
+77.2%	+5.8%	+65.6%	+9.5%	+226.8%

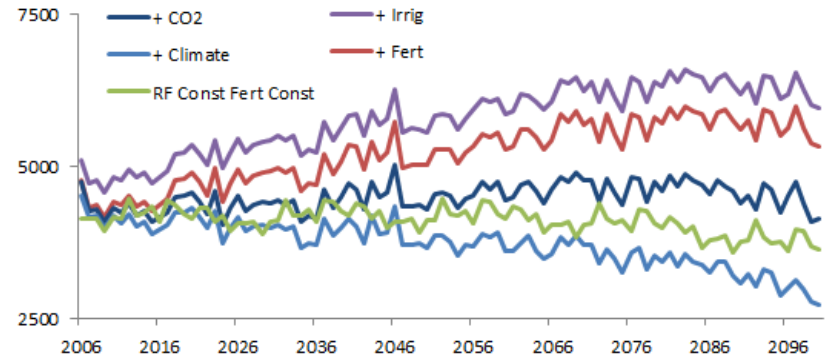
\*UNFAO only using Yields for CLM Crop Types over All Crop Areas

# Global SSP5 RCP 8.5 Analysis (All Crops) Area, Yield, N

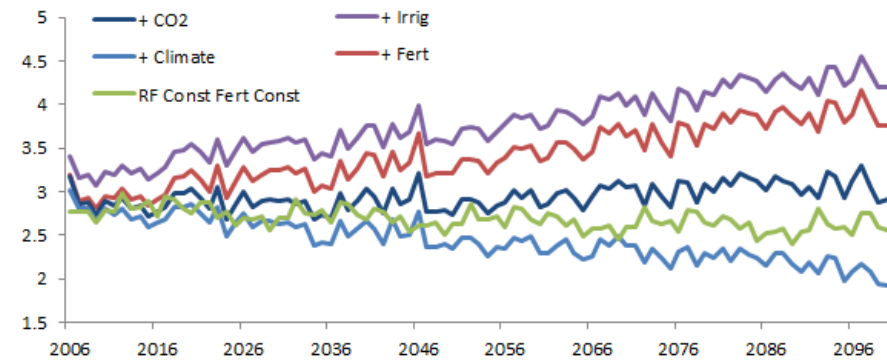
SSP5 RCP 8.5 Global Crop Area (millions hectares)



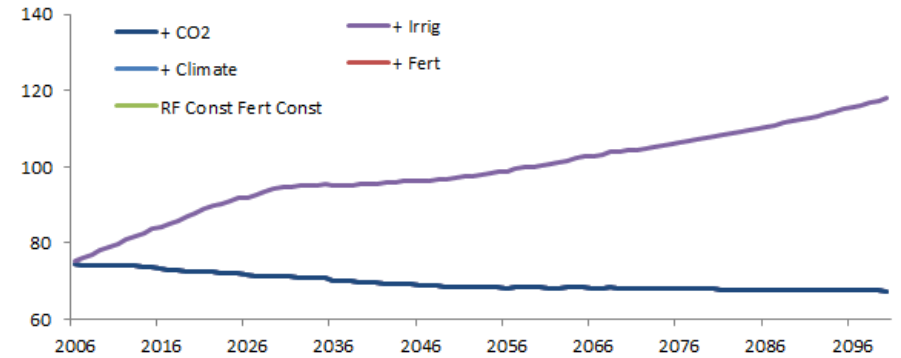
SSP5 RCP 8.5 Global Crop Production (millions tonnes)



SSP5 RCP 8.5 Global Crop Yield (tonnes/ha)



SSP5 RCP 8.5 Global N Fertilizer (kilograms/ha)

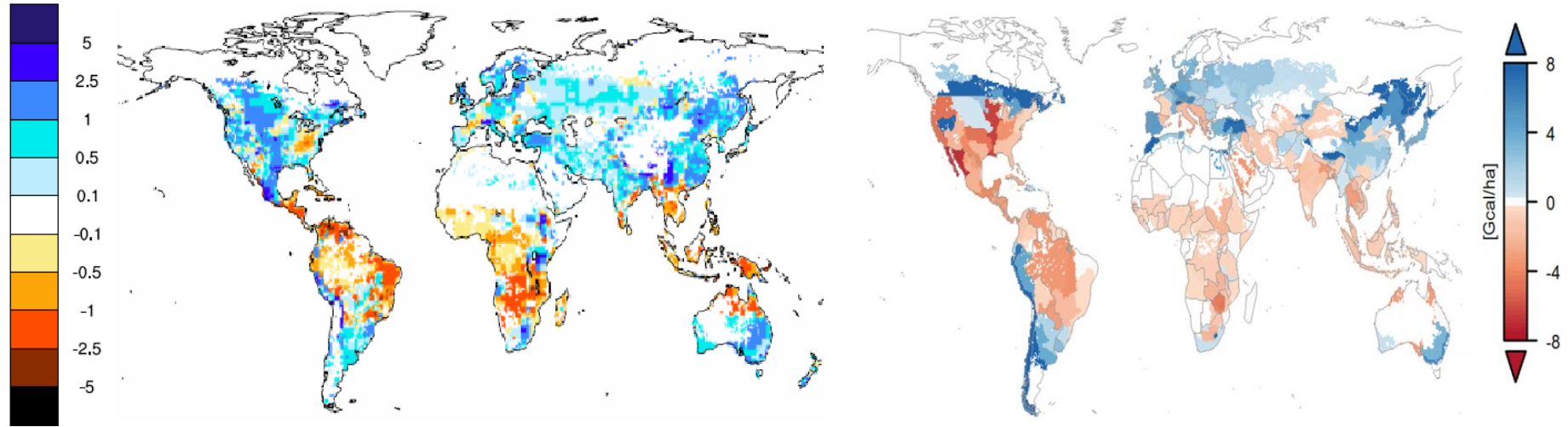


Area Effect	Clim Effect	CO2 Effect	N Fert Effect	Irrig Effect	Total Effect
-9.1%	-20.4%	+46.0%	+27.3%	+10.7%	+49.0%

# CLM Crop versus AgMIP changes for RCP 8.5 to 2100

CLM crop yield changes (Tonnes/Ha)

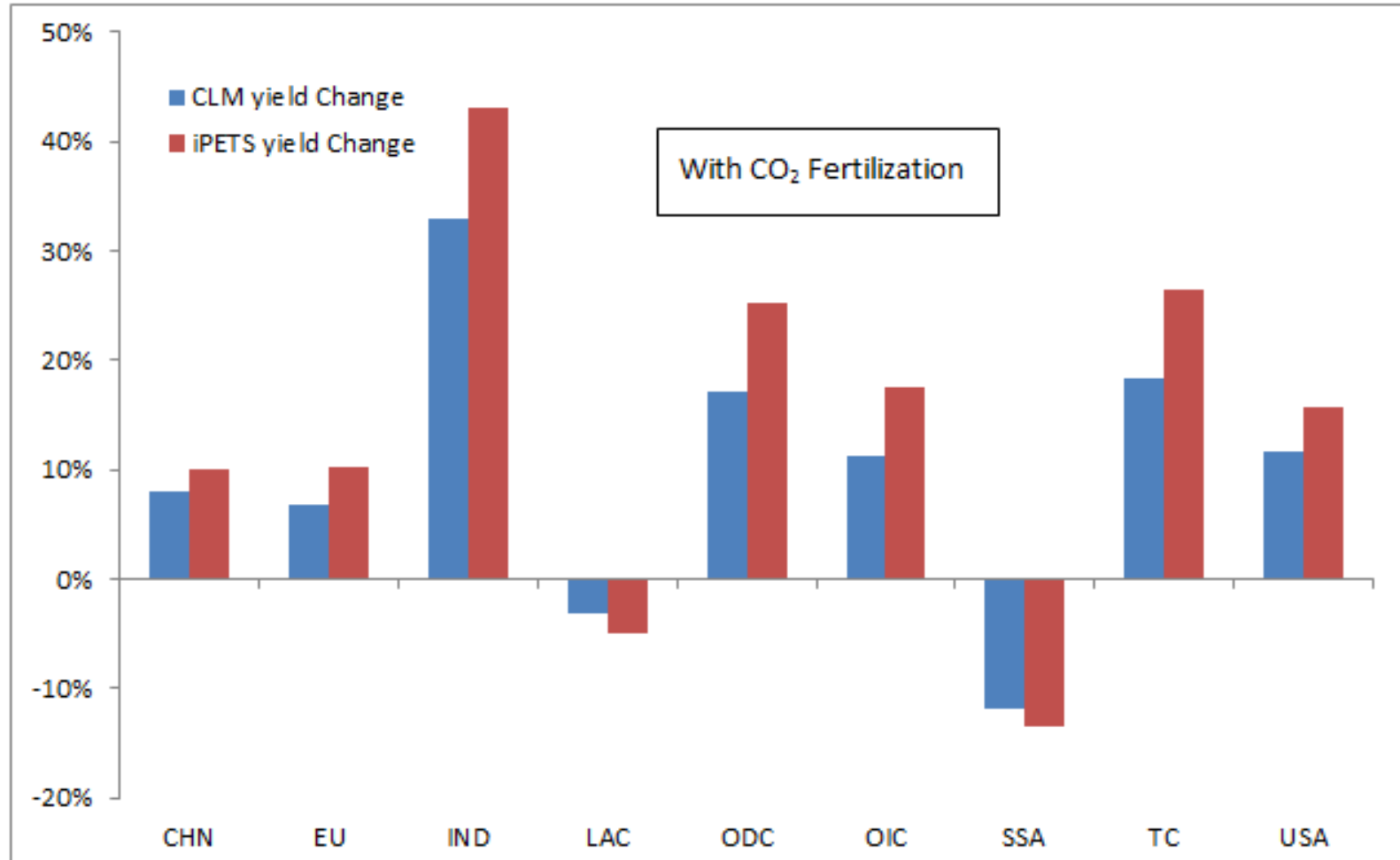
AgMIP productivity changes (Gcal/ha)



Change under RCP 8.5 climate with CO<sub>2</sub> fertilization for average crop. AgMIP results are median change of all GGCM×GCM combinations (n=30) (From Müller et al. 2015). Cropping areas, fertilizer and irrigation are held constant at 2005 values for both results.



# CLM Crop and iPETS changes for SSP 5 RCP 8.5 to 2100



Change under RCP 8.5 climate with CO<sub>2</sub> fertilization for average and individual crops. Cropping areas, fertilizer and irrigation are held constant at 2005 values for both results.

# iPETS for SSP 5 RCP 8.5 vs no Climate Change at 2100

