GLOBAL RESEARCH ALLIANCE ON AGRICULTURAL GREENHOUSE GASES

Engagement meeting
Izmir, November 19th 2015

Soil Carbon & Nitrogen cycling cross-cutting group (SCNC)

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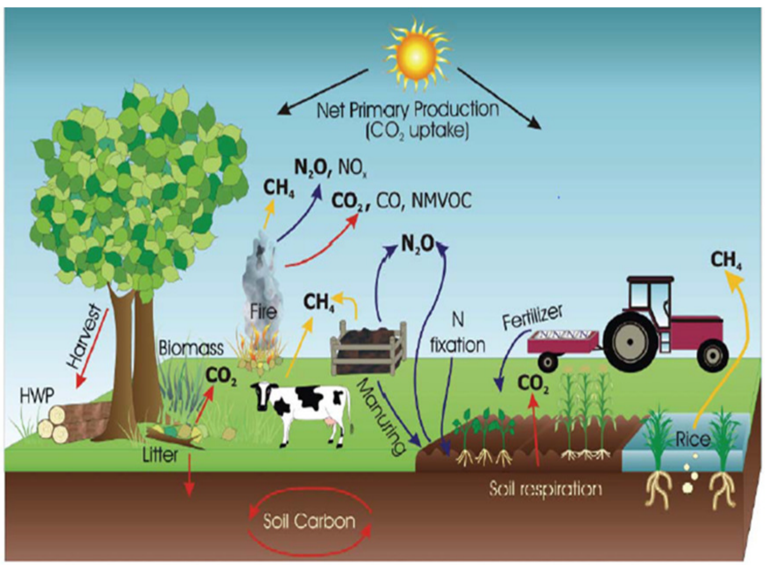
INRA SCIENCE & IMPACT

Soil Carbon & Nitrogen Cycling Cross-Cutting Group

Group Vision :

In close collaboration with research groups, share knowledge and advance understanding through **modeling tools** to:

- **Reduce uncertainties on soil-based GHG emissions** and assess **mitigation options,**
- Assess **adaptation options** and feedbacks on GHG emissions**,**
- Assess the potential of **soil carbon sequestration**



Source: Paustian et al. (2006)

SCNC group :

✓ 27 members countries, co-chaired by France (Jean-François Soussana) and Australia (Lee Nelson)

✓ Funding obtained in Australia and France to support coordination

✓ Partnership initiated: AgMIP, GeoGlam ;

✓ Funded projects (GHG research call, supported by Canada, NZ, USA and European countries within FACCE JPI): CNMIP, Models4pastures, CometGLOBAL, MAGGNET, & MACSUR

SCNC group: 3 activities

Network 1. Model inter-comparison for GHG emissions and test of mitigation options

- Four members leading components on crops and temperate grasslands (France, New-Zealand, Australia, USA). Tropical grasslands planned led by Australia and Brazil.
- 12 members participate (Australia, Brazil, Canada, China, France, Germany, Italy, New Zealand, Spain, Switzerland, United Kingdom, and the United States), collaboration with India. More members expected for mitigation options modeling

Network 2. Model inter-comparison for climate change impacts on agricultural GHG emissions and adaptation options (Joined activity with AgMIP)

- Two members lead the pilot temperate grassland component (France, New-Zealand). Additional component for tropical grasslands led by Australia planned.
- Crop component for GHGs to be launched with AgMIP
- 8 member countries participate so far (Australia, Belgium, Canada, France, Germany, New Zealand, United Kingdom, and the United States).

Network 3. Soil carbon sequestration (planning stage)

1. Model inter-comparison & test of mitigation options

An international & collaborative work

Objectives:

i) To benchmark & inter-compare crop and grassland models for agricultural GHG emissions and removals,

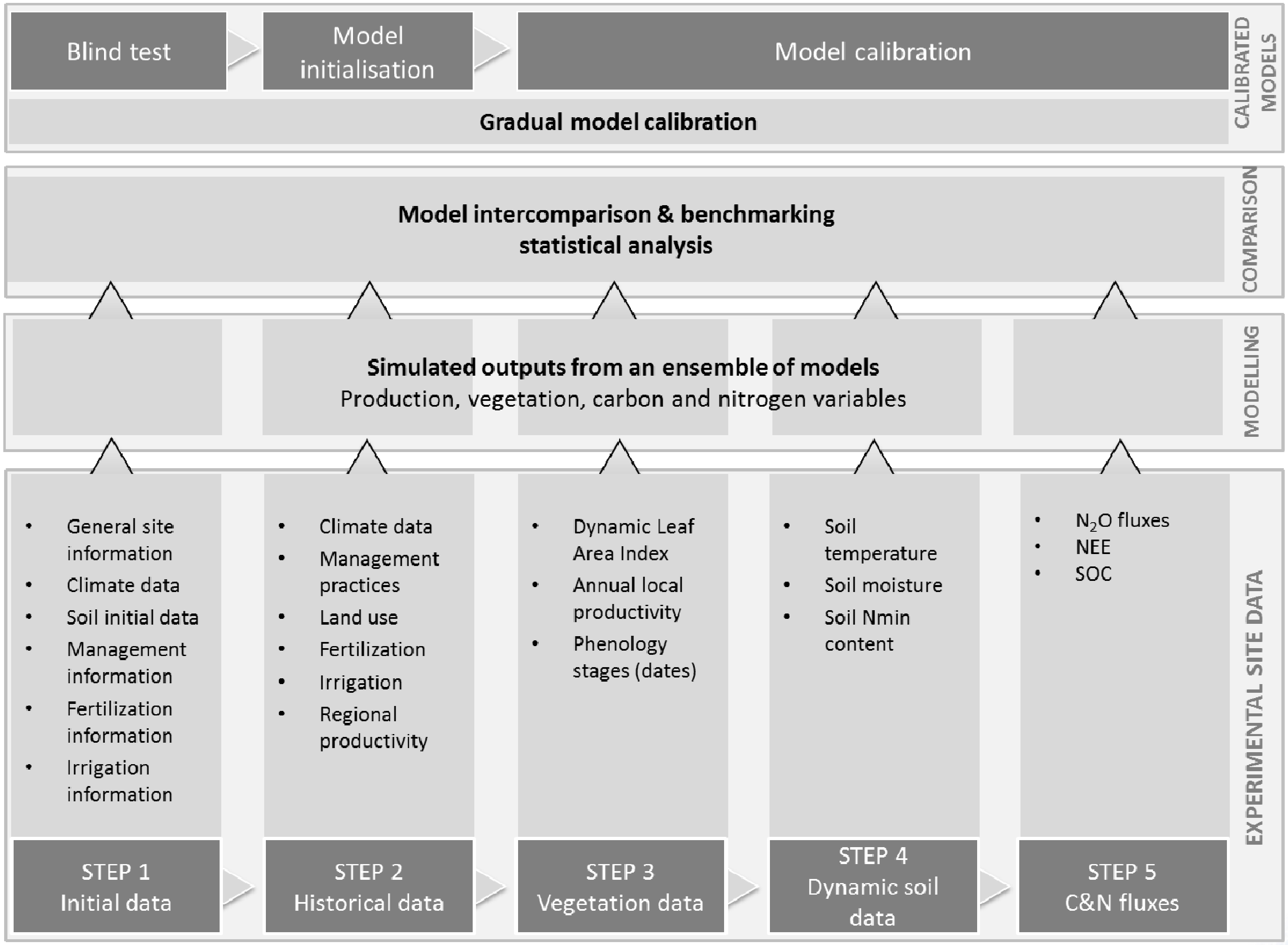
ii) To test mitigation options by system/region

- **> 40 scientists**: modelers, site data providers, statisticians
- **10 sites** (5 grassland sites & 5 cropland sites)
- **24 models (crops, grasslands, ecosystems)**
- **Blind procedure**, multi-step approach, gradual calibration, reduced uncertainties.
- **Model improvement**

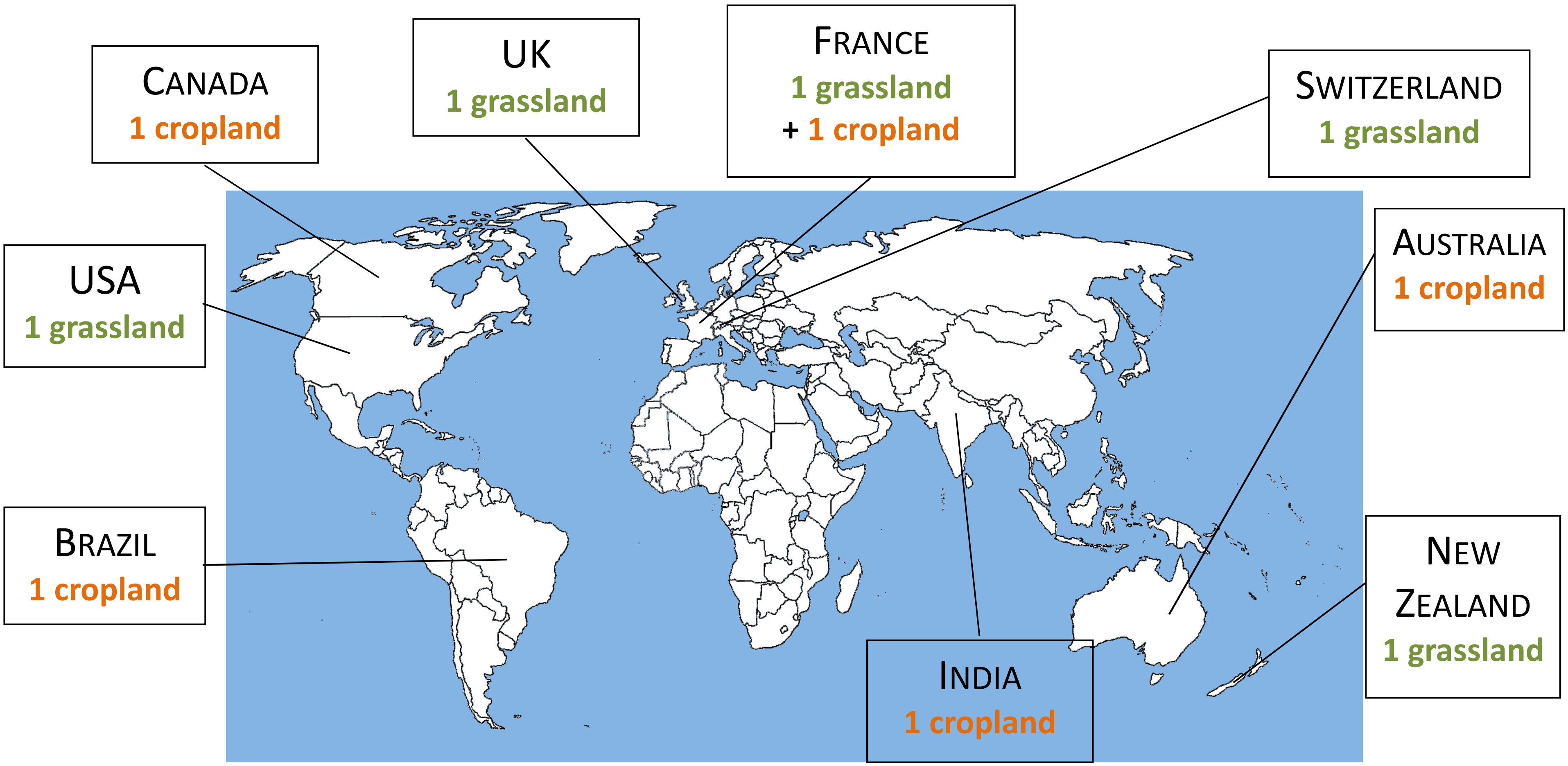

1st workshop 'Model intercomparison'
Paris, France – March 2014


2nd workshop 'Model intercomparison'
Fort Collins, USA – March 2015

1. Model inter-comparison & benchmarking



10 sites for model benchmarking

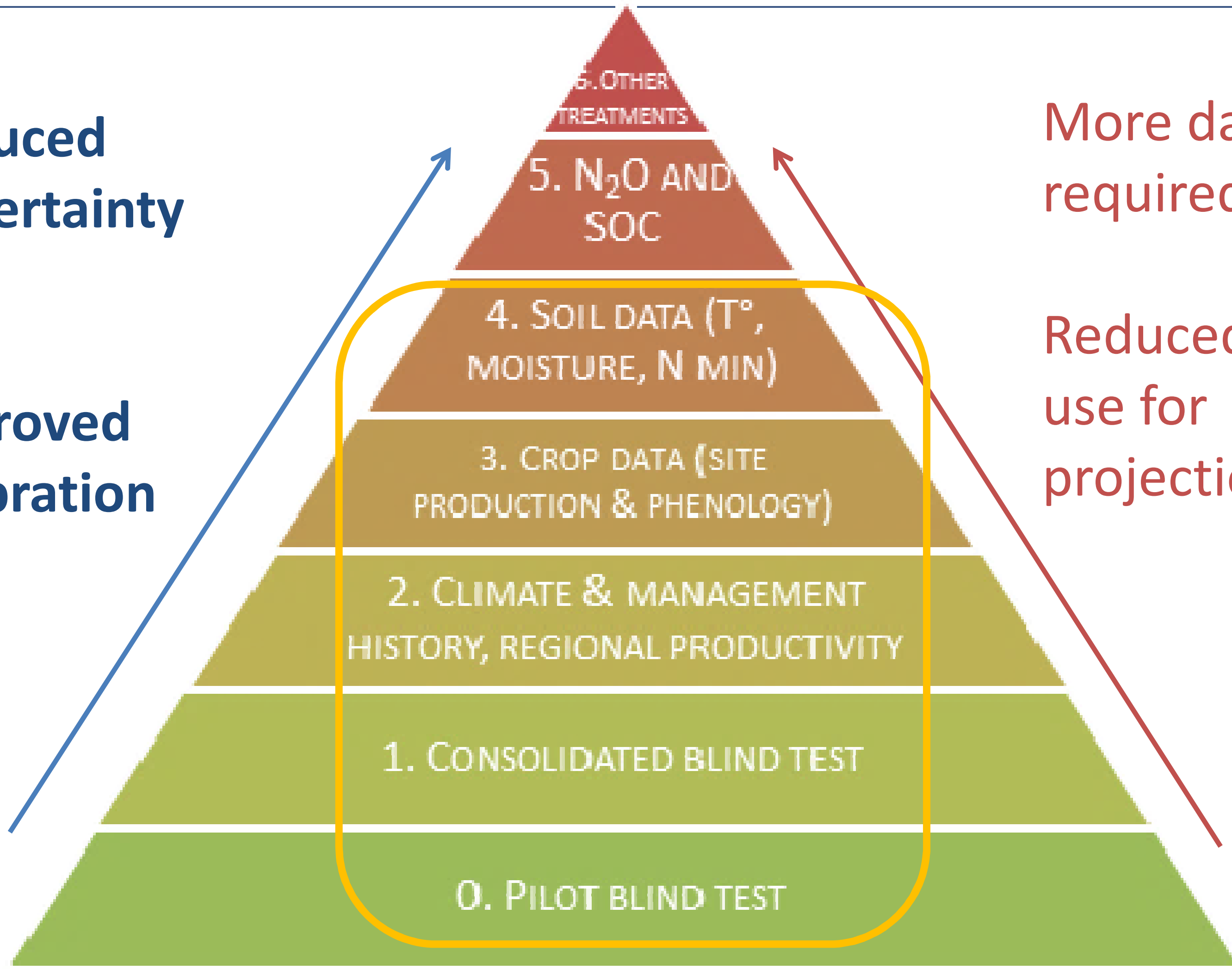


Providing extensive and high quality data sets:
Climate, Soil profile, Ag. practices, Production, GHG emissions, C cycle, N cycle

Steps for model benchmarking and calibration

Reduced Uncertainty

Improved calibration



More data required

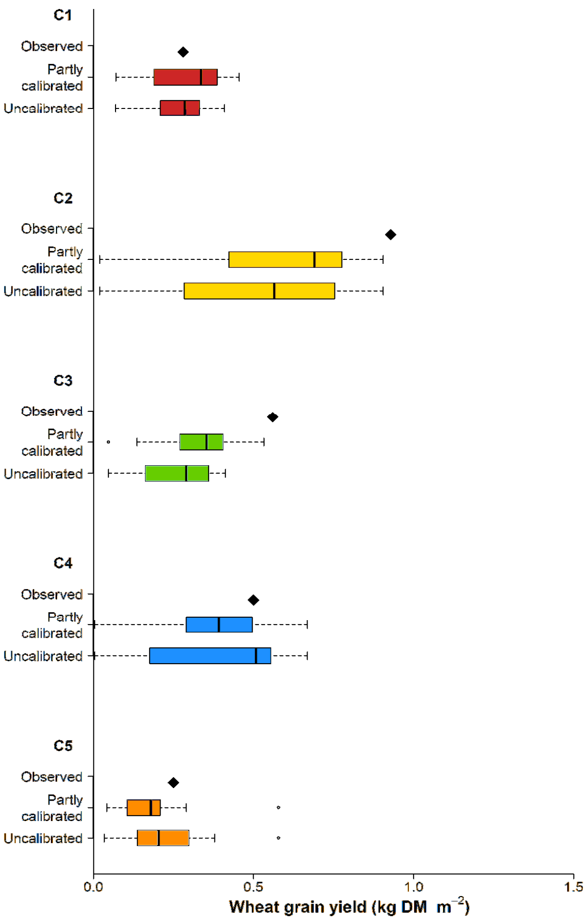
Reduced use for projections

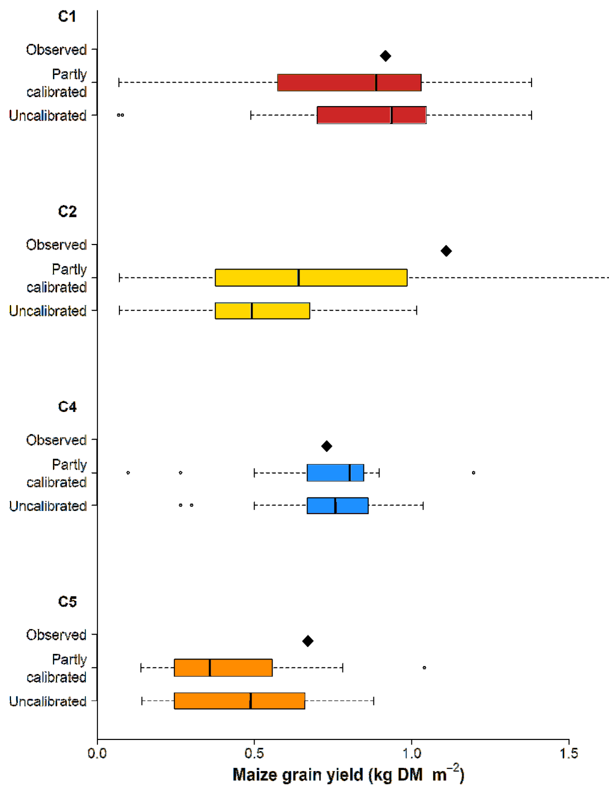
→ Comparison of simulated results with experimental data at each step

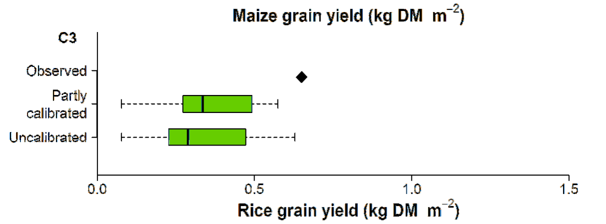
→ Gradual information release : which data help improving simulation accuracy?

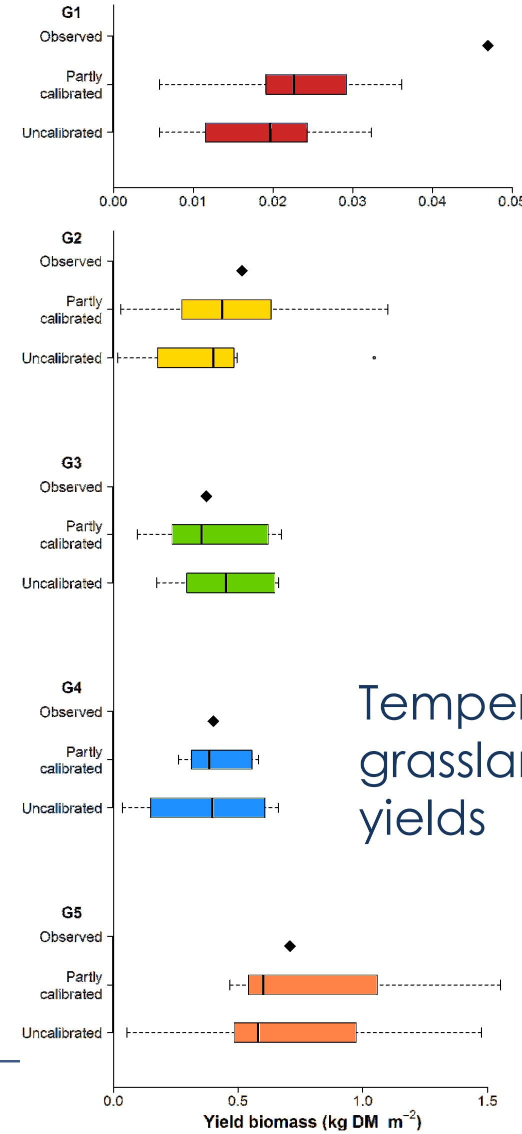
Multi- model medians are robust predictors of yields

(First results for steps 1 and 2: *no site specific data provided*)







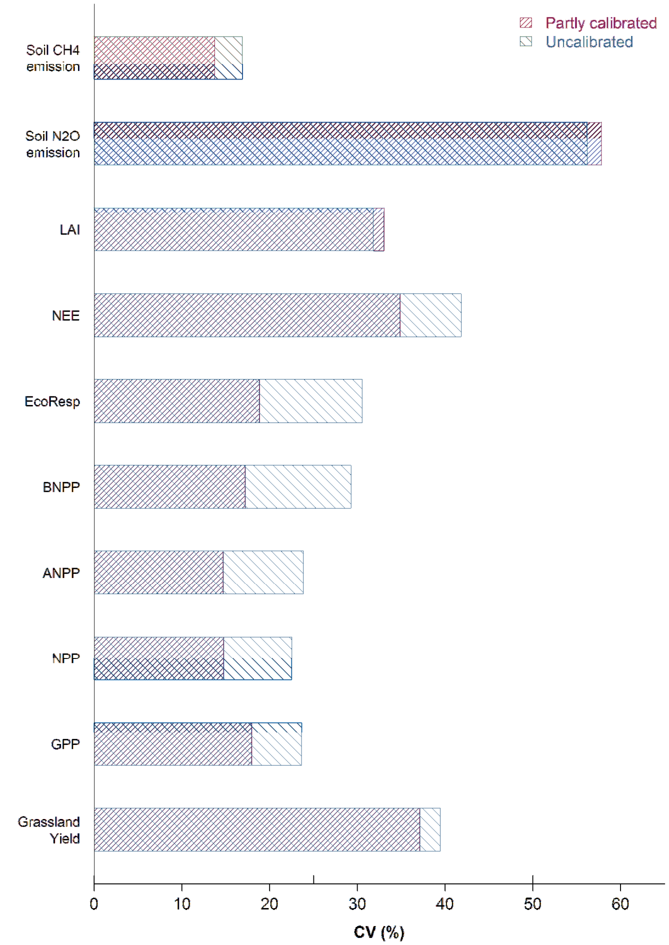


Temperate grasslands yields

Crop yields
(Wheat, Corn, Rice)

Which variability across models for GHG emissions and C & N cycles variables?

(First results for steps 1 and 2: *no site specific data provided*)



Temperate grasslands

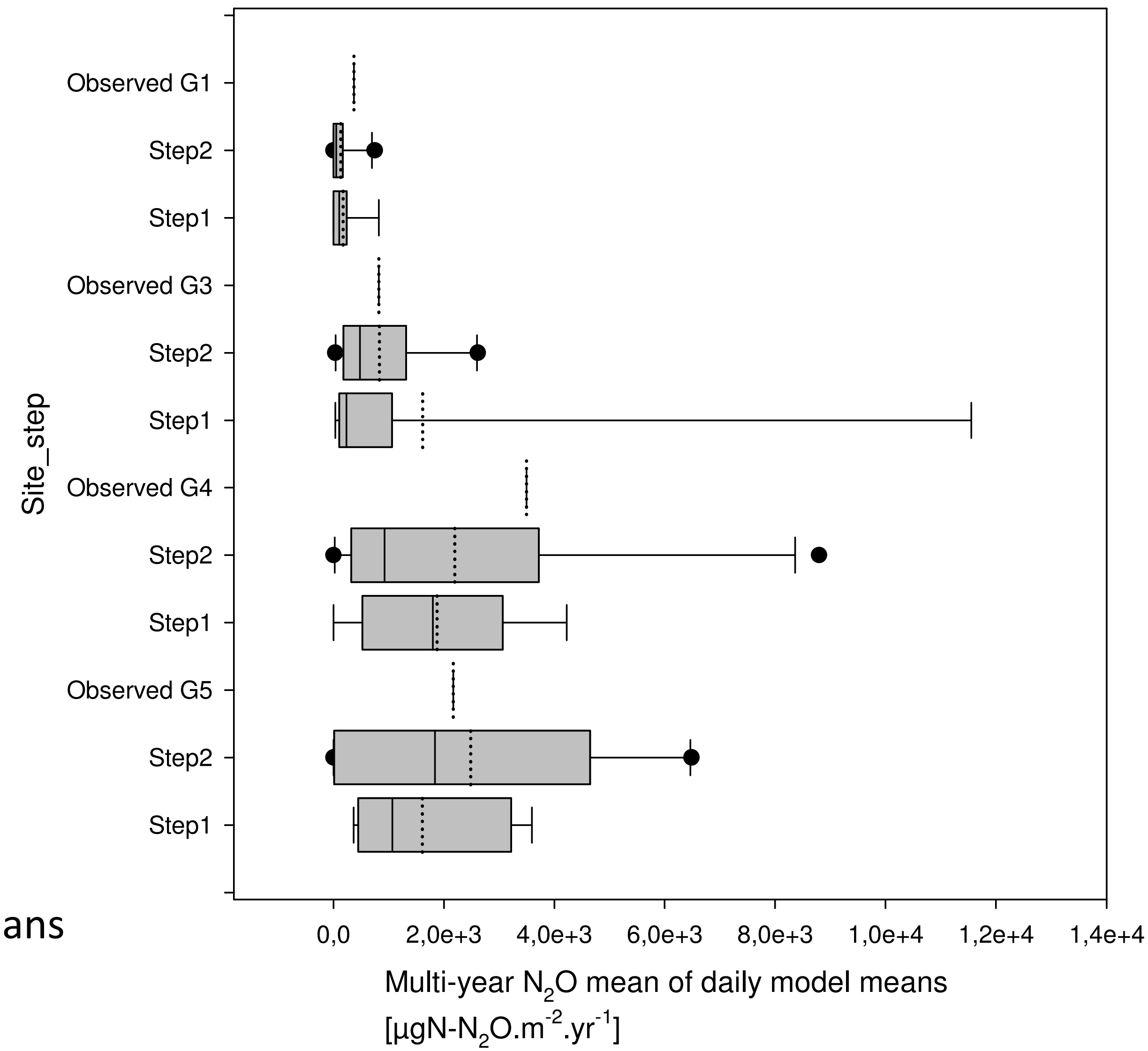
→ DETERMINE the number of models to be used for regional/site specific simulations,

→ BETTER CALIBRATION of models for international simulations

Multi- model means are robust predictors of N2O emissions

(First results for steps 1 and 2: *no site specific data provided*)

Temperate grasslands



Full lines = medians
Dotted = means

2. Modeling sensitivity to climate change

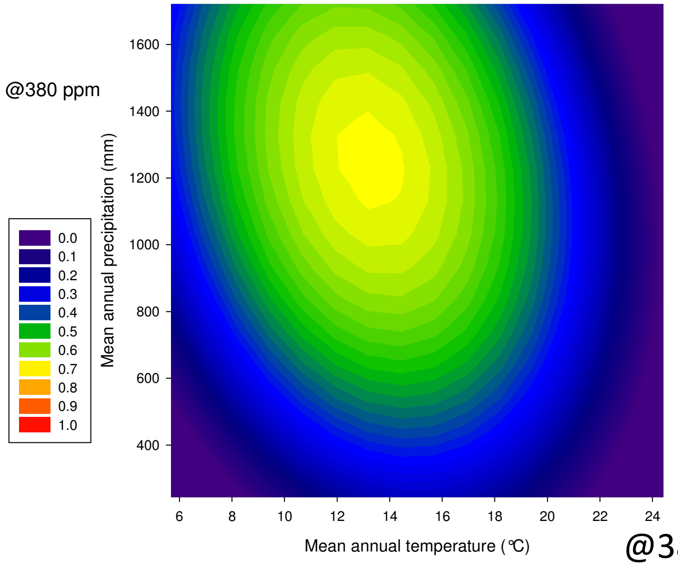
An international exercise joined with the AgMIP program;

Component 1. Temperate grasslands

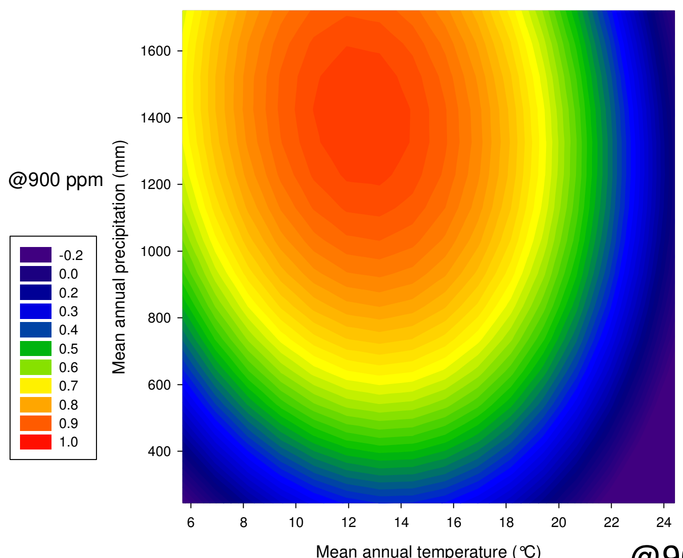
- **16 temperate grassland sites from 7 countries**, covering a large climate gradient over 3 continents (mean annual temperature T from 7 to 14°C; mean annual precipitation P from 380 to 1380 mm)
- **10 models:** 7 site-calibrated models, 3 global ecosystem models ;
- Using 99 combinations of probabilistic climate change **scenarios {Temperature, Precipitation, CO_2}** modifying **historical climate data** (30 years) ;

- Calculation of statistical emulators for multi-models
- Adaptation options providing increased resilience to climate change

Multi-model estimate of grassland yields with temperature and precipitation change



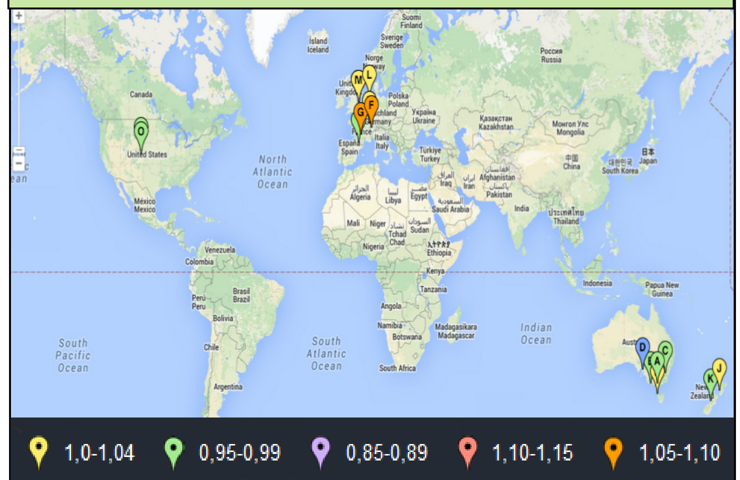
@380 ppm CO_2



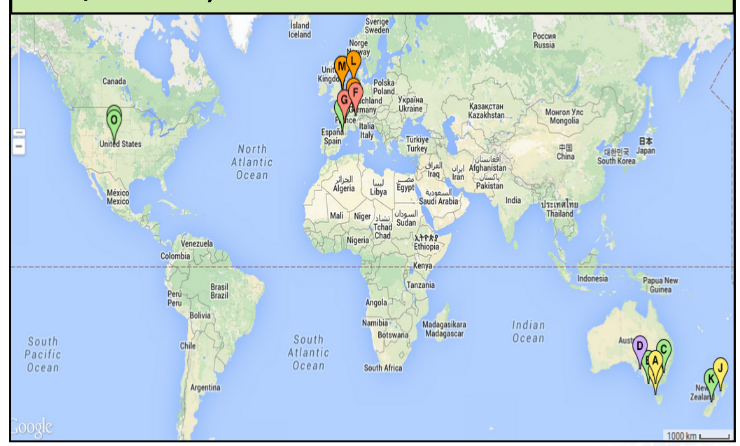
@900 ppm CO_2

Multi-model estimate of relative N_2O emissions by 2050 (RCP 4.5 & 8.5)

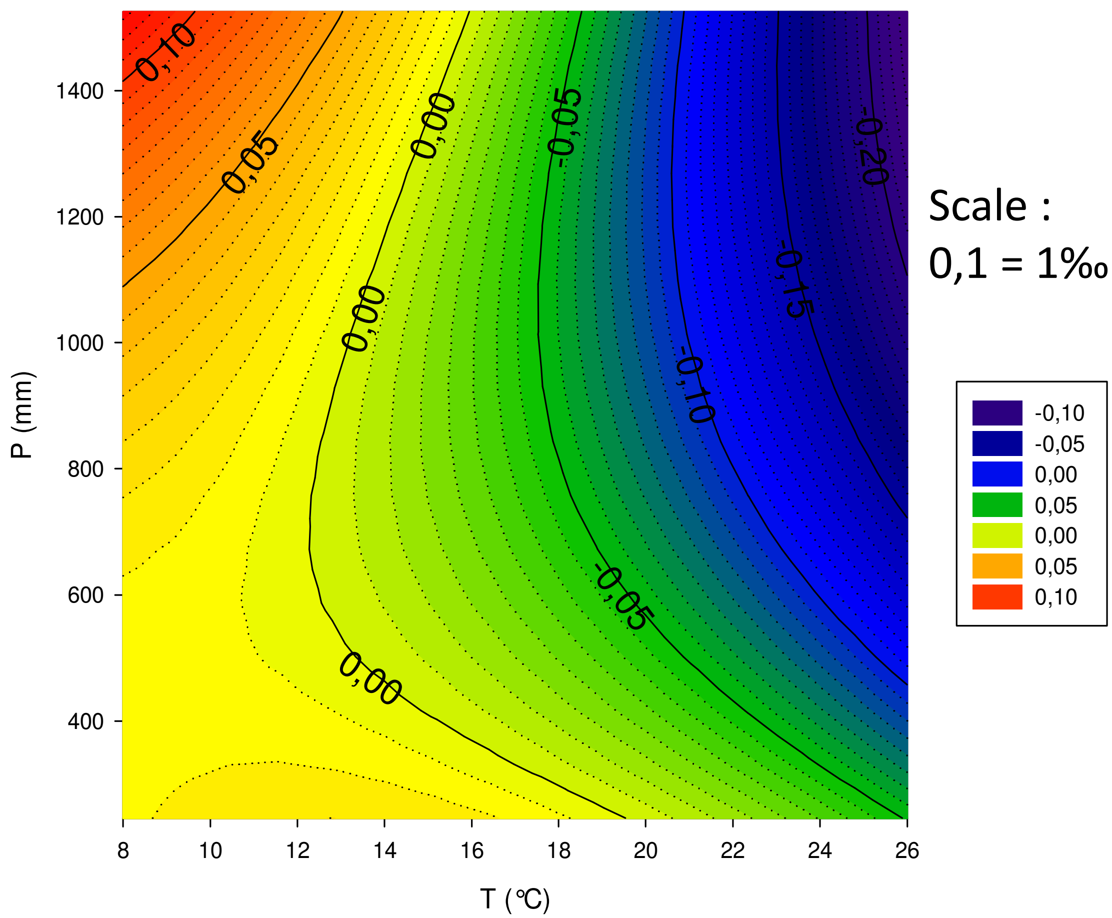
Relative N_2O emissions (2050s RCP 4.5/actual)



Relative N_2O emissions (2050s RCP 8.5/actual)



Multi-model estimate of grassland soil carbon sensitivity to temperature & precipitation



Scale :
0,1 = 1‰

(6 sites in Australia and New-Zealand, 3 models, $r^2=0{,}774$; $p<0{,}001$)

Activity 3: Soil Carbon Sequestration

Why?

2-3 times more carbon in soil organic matter than in atmospheric CO_2 (IPCC, 2013),

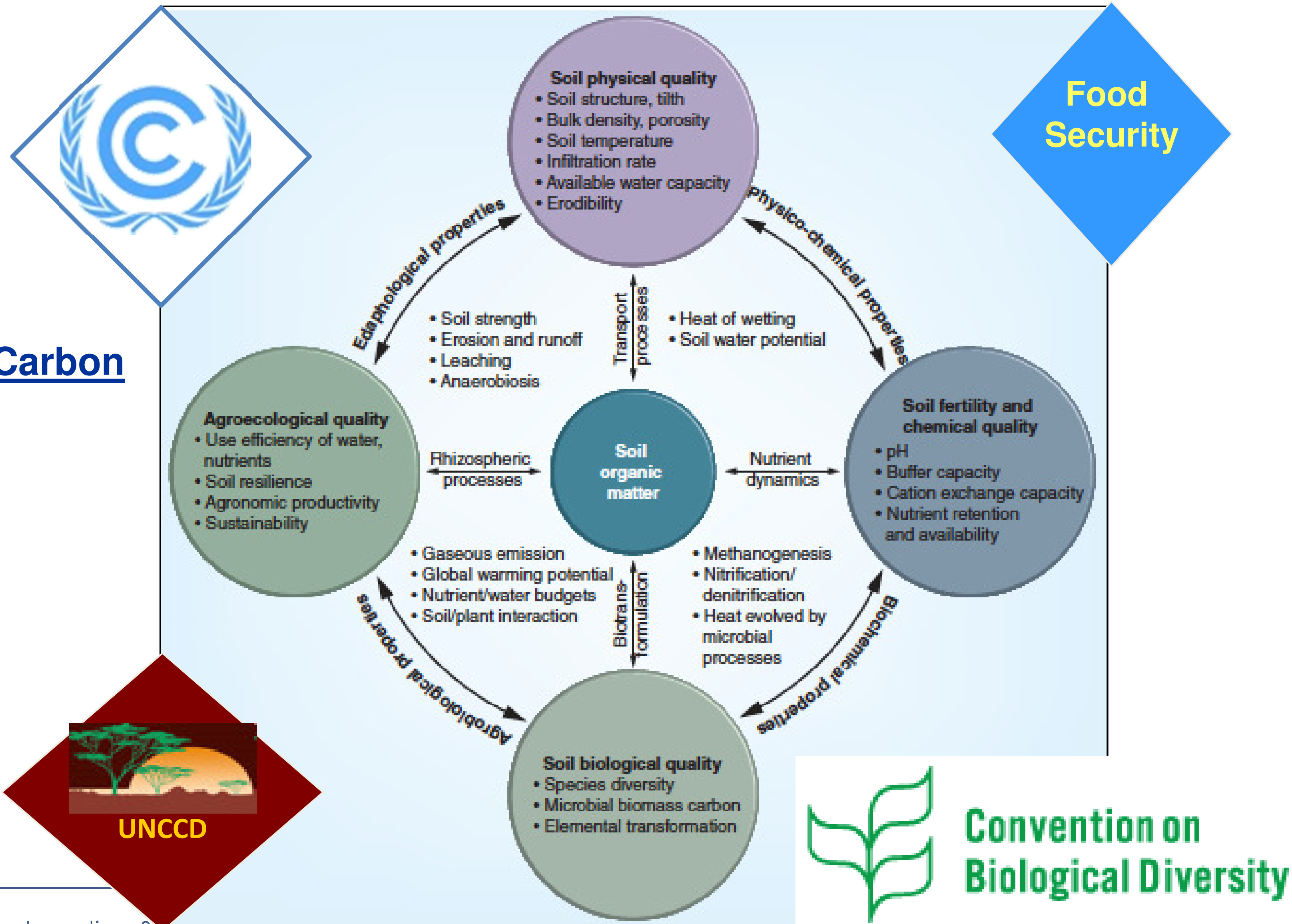
1.2 billion metric tons carbon could be stored annually in global cropland and grassland soils (IPCC, 2014), equivalent to a storage rate of 4 per mil in top soils,

24-40 million metric tons additional grains could be produced in developing countries by storing an additional ton of carbon in soil organic matter (Lal , 2006)

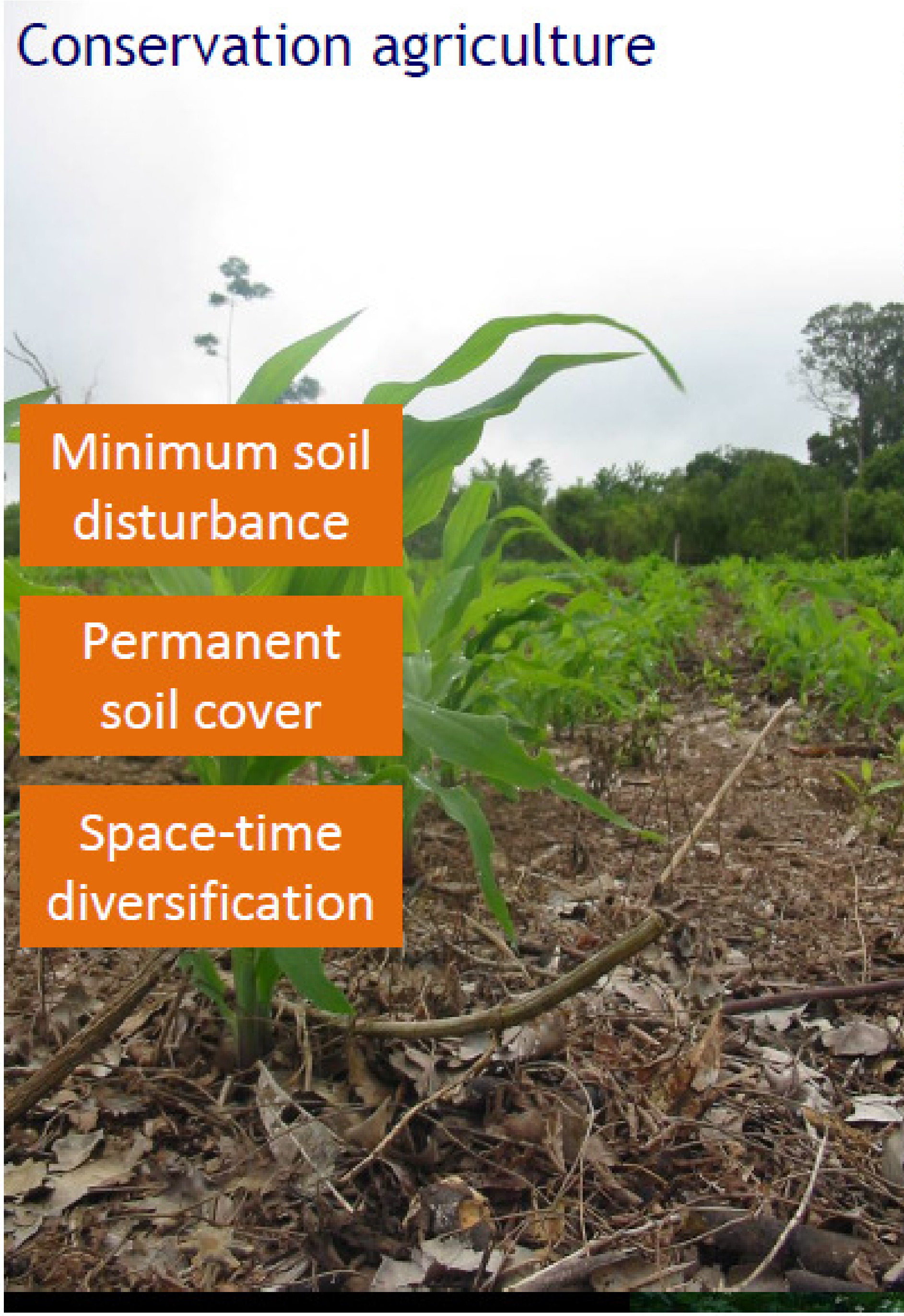
Close to half of the agricultural soils are estimated to be degraded , leading to grain losses estimated at 1.2 billion US $ globally (FAO, 2006)

Soil Organic Matter : multiple benefits

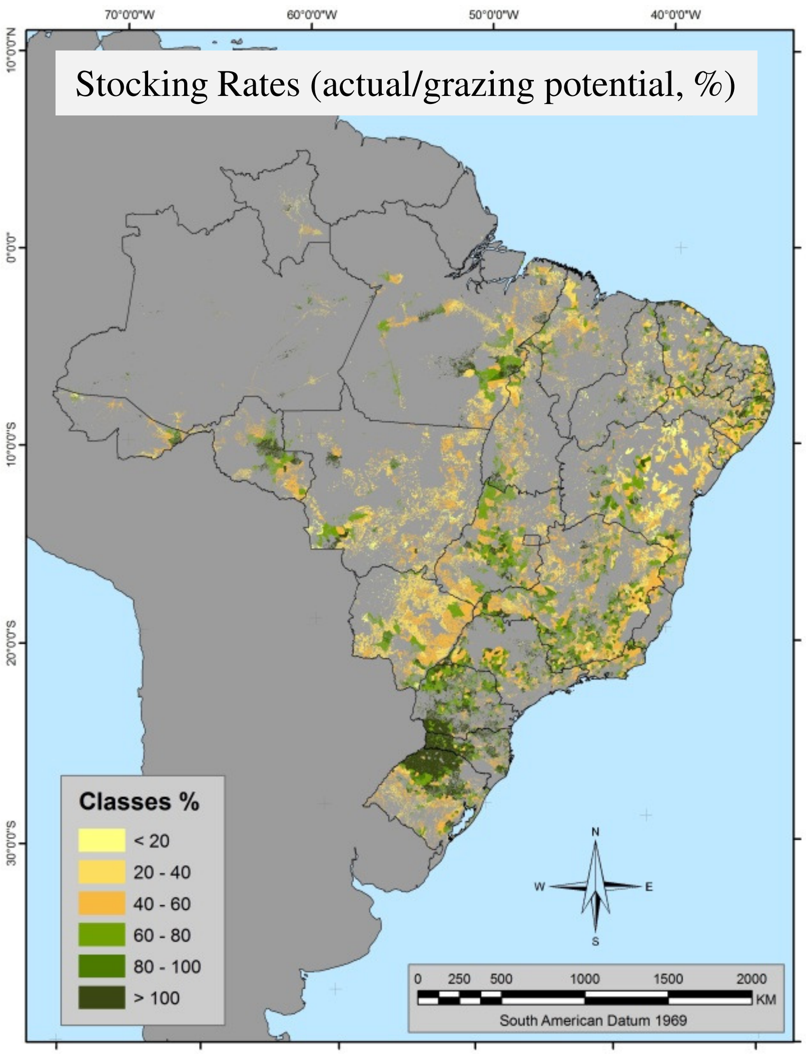
Soil Carbon



Conservation agriculture

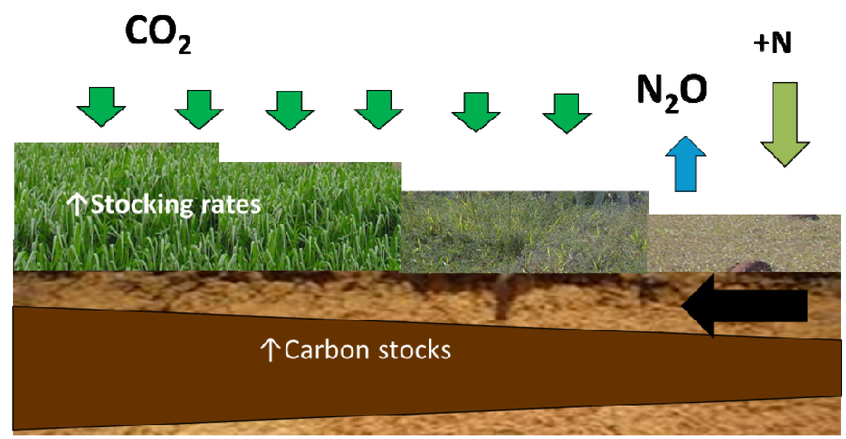


Tropical pasture restoration and intensification



(Courtesy of L. G. Barioni, Embrapa)

Tropical pasture intensification:
Soil Carbon Dynamics and Nitrogen impacts



Soil carbon sequestration and food security

- A key issue for agriculture proposed for the Lima-Paris Action Agenda (LPAA),
- A multi-stakeholder international action plan, likely to be announced by the French minister for agriculture at the time of COP21,
- Supported by an international research program,
- GRA could host this research program, in collaboration with other programs/institutions which have expressed their interest:
  - FAO, UNEP, CGIAR
  - AgMIP, Global Soil Partnership, Global Carbon project,
  - Global Soil Forum, Economics of Land Degradation,
  - ISRIC, FACCE-JPI (Europe)

Provisional themes of the research program on soil carbon sequestration

(Conclusions from a side-event to the 'Our Common Future under Climate Change' science conference, July 7, 2015)

- Improving estimates of the baseline of soil carbon sequestration (or loss) and of current soil carbon stocks;
- Design and co-construction of agronomic strategies and practices for soil carbon sequestration, including an assessment of their performances and of trade-offs among multiple objectives;
- Metrics and methods for monitoring, reporting and verification (MRV) of soil carbon sequestration (farm, landscape, region, country);
- Institutional arrangements and public policies, including financial mechanisms, that aim at promoting and rewarding relevant practices ;

First planning stages : joined LRG and SCNC meeting – Lodi, June 2015,

Data base
- Assembling site data on Cseq. and practices (multiples sites, surveys)
- GRN, Soil C-N, CCAFS

Reference data
- Testing practices impacts on Cseq. (small number of long-term experiments)
- GRN, CCAFS, MAGNET (Cropland group)

Cseq. maps
- Scaling Cseq. potential, productivity, GHG balance. Include inputs of feed and manure networks of LRG.
- Soil C-N, CCAFS

MACCs; Multi-indicator
- Costs and benefits (change in gross margin would be a proxy), social equity, environmental dimensions
- LRG, CCAFS, Global Livestock Agenda

Training programs
- Barriers, capacity building, stakeholder engagement
- Implementation, field guides
- Global Livestock Agenda, LRG, CCAFS

Methodology
- MRV design, methodology for soil C sampling
- IMM group, Soil C-N group

Establish New sites
- Identifying where to establish new sites with options
- GRN, CCAFS, MAGNET (Cropland group), CN group

National design study
- Package for submitting a design study

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Thank you for your attention!

Visit our webpage:

http://globalresearchalliance.org/research/soil-carbon-nitrogen-cycling/