



International Center for Tropical Agriculture  
Since 1967 / *Science to cultivate change*

# Soil Organic Matter for Climate Change Mitigation:

## Boon or Bane for Food Security?

24 August 2015  
Wageningen Soil Conference

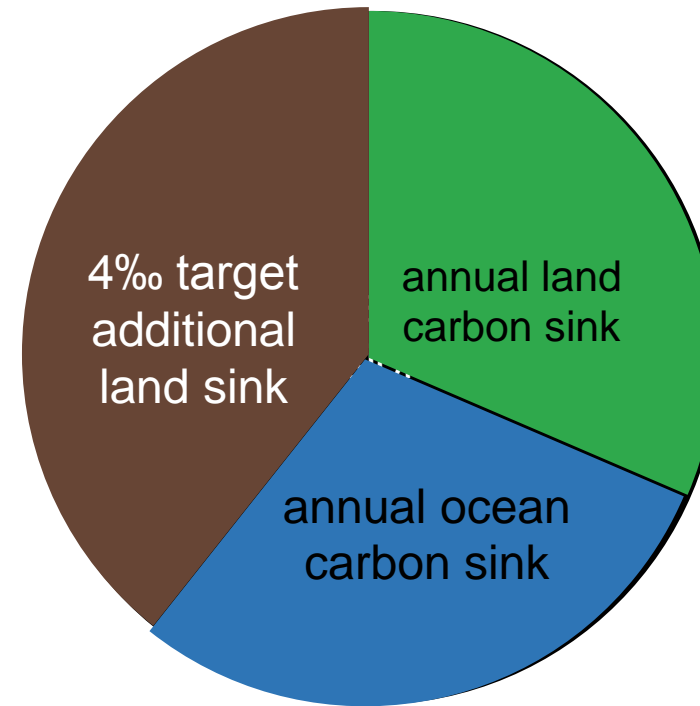
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# 4‰

0.4% per year sequestration soil organic carbon



Soussana,  
Saint-Macary,  
Chotte 2015

In March of 2015 Minister Le Foll of France announced the establishment of an international research program “to improve soil organic matter at an annual rate of 4‰<sup>1</sup>”, and that “such an increase would offset emissions of green house gasses on the planet<sup>2</sup>”

<sup>1</sup> Press release ‘Contribution de l’agriculture à la lutte contre le changement climatique : Stéphane Le Foll annonce le lancement d’un projet de recherche international : le « 4 pour 1000 » . MAAF, Paris, March 17, 2015.

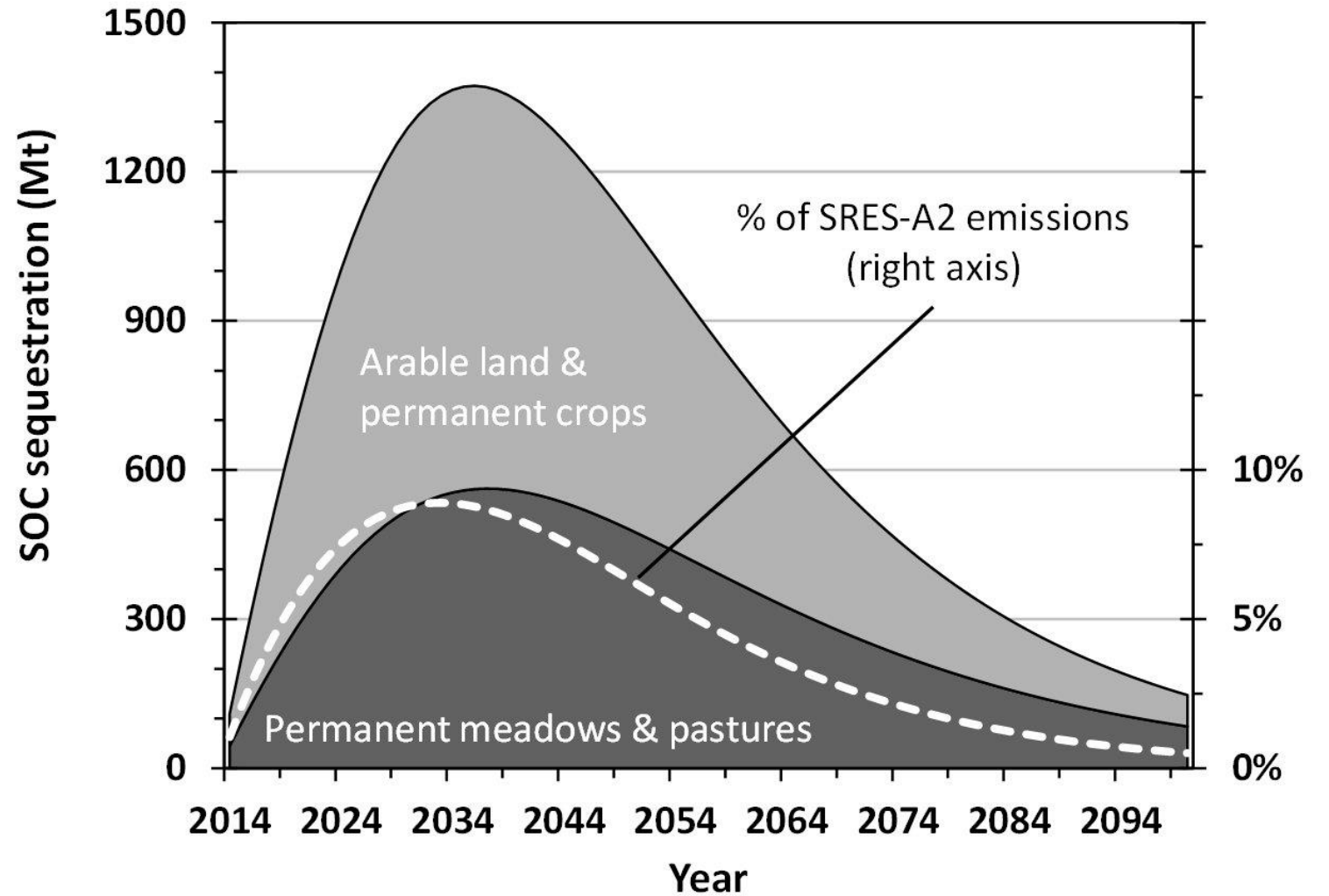
<sup>2</sup> See <http://agriculture.gouv.fr/Cop21-le-4-pour-1000>

# 3.5

Gt/year Carbon required for the 4‰ target

- 0.4 – 1.2 Gt estimated total carbon sequestration potential in cropland soils of the world
- 2.8 – 3.0 Gt for all soils of the world

(Lal 2010)



Optimistic scenario (1 t/ha/yr) and rapid implementation, peak of carbon sequestration in soil predicted for 2030 - coherent with the need for early action, but far short of the 4‰ target.

(Sommer and Bossio 2014)

# 50 to 70

% loss of soil carbon stocks in cultivated soils (Lal 2004)

Restoring degraded soils affords substantial opportunities to sequester carbon

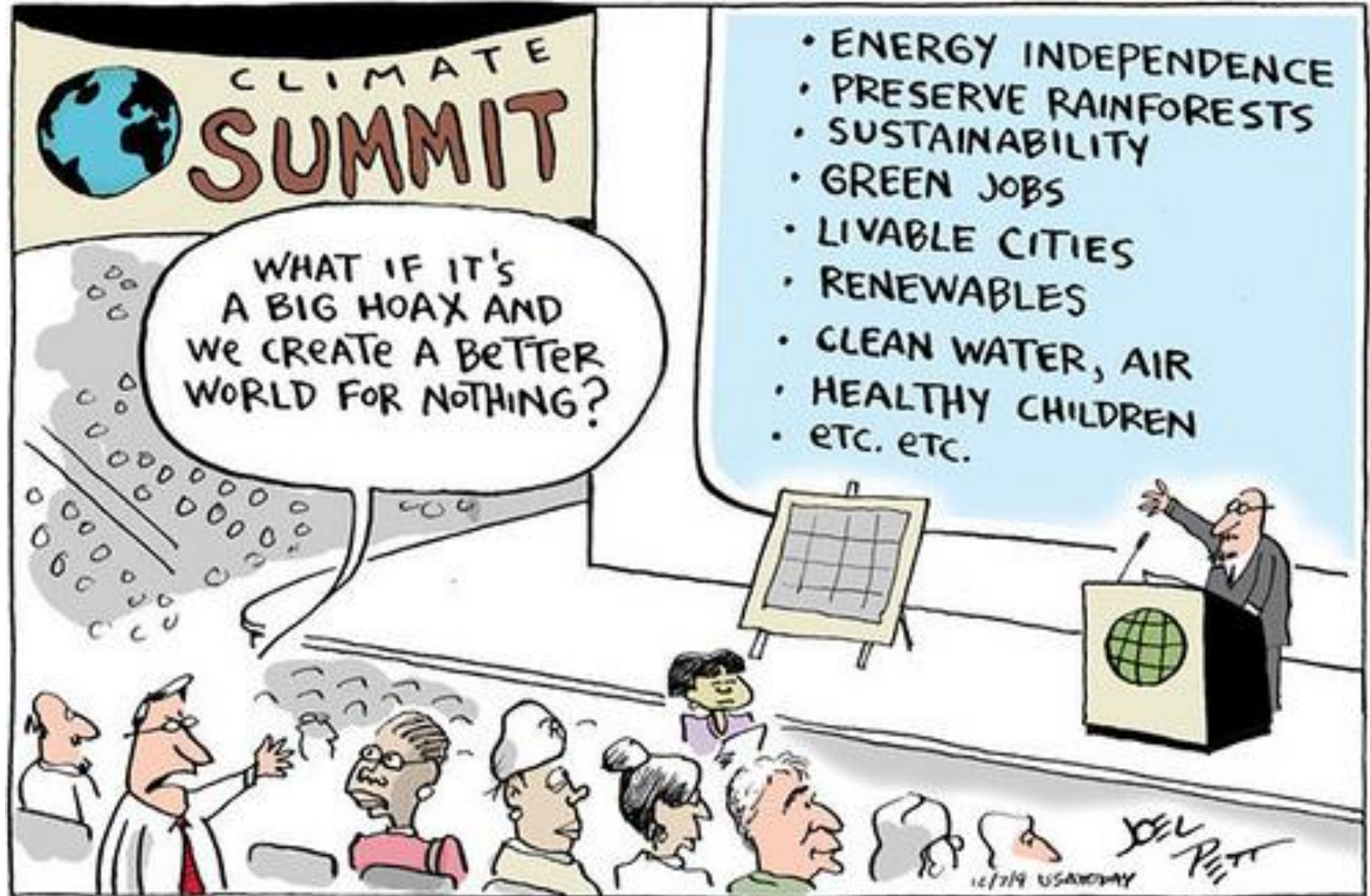
Increase of 1 ton of soil carbon pool of degraded cropland soils may increase crop yield by 30 to 50 kilograms per hectare (kg/ha) for wheat, 100 to 300 kg/ha for maize, and 30 - 50kg/ha for soybeans (Lal 2006)



# SOIL Organic Matter

- = SOIL FERTILITY
- = PRODUCTIVITY
- = FOOD SECURITY

+ RESTORED LAND AND ECOSYSTEM SERVICES  
water cycle regulation  
climate resilience  
...



The promise of

*Climate Smart Agriculture?*

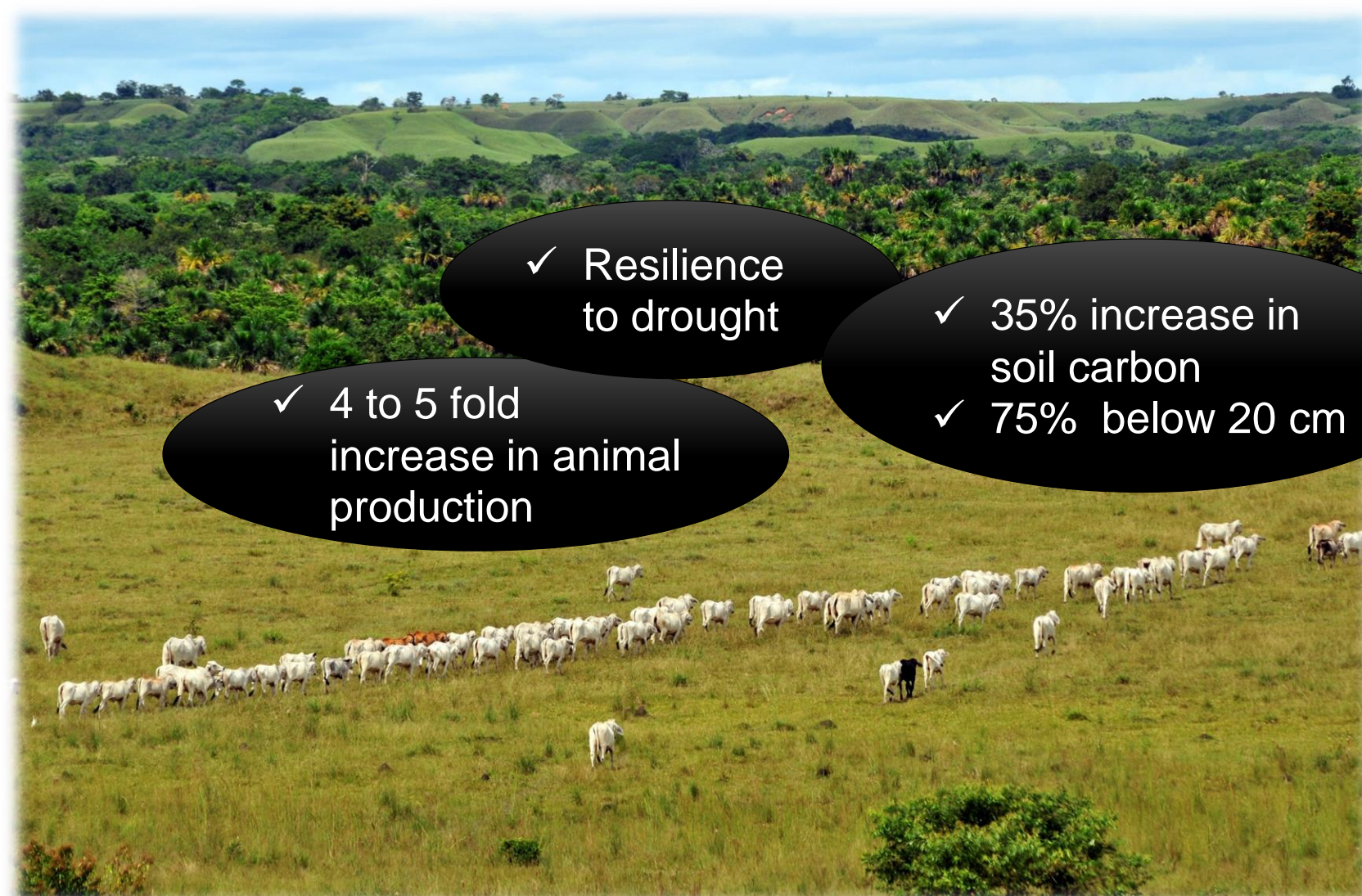
ADAPTATION

FOOD  
SECURITY

MITIGATION



# Restoring degraded pastures with tropical forages – storing carbon at depth

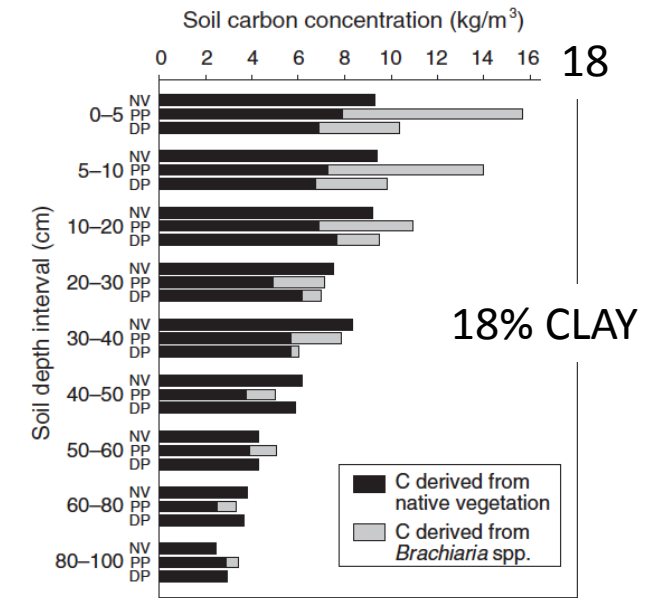
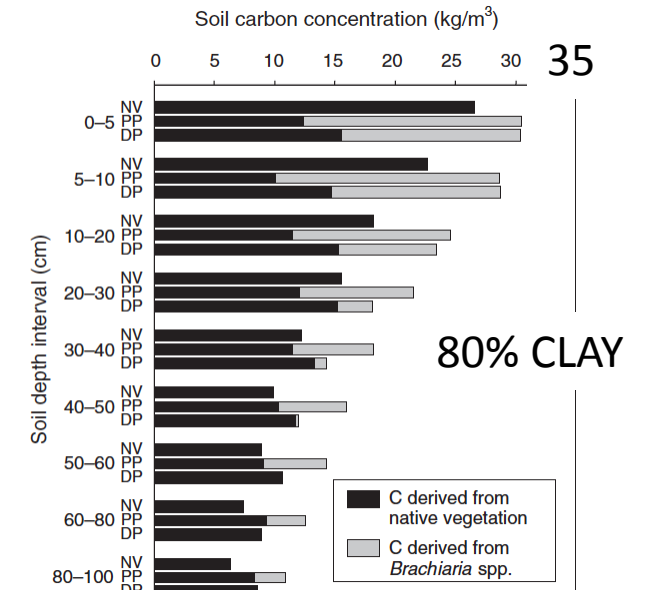


✓ Resilience to drought

✓ 4 to 5 fold increase in animal production

✓ 35% increase in soil carbon

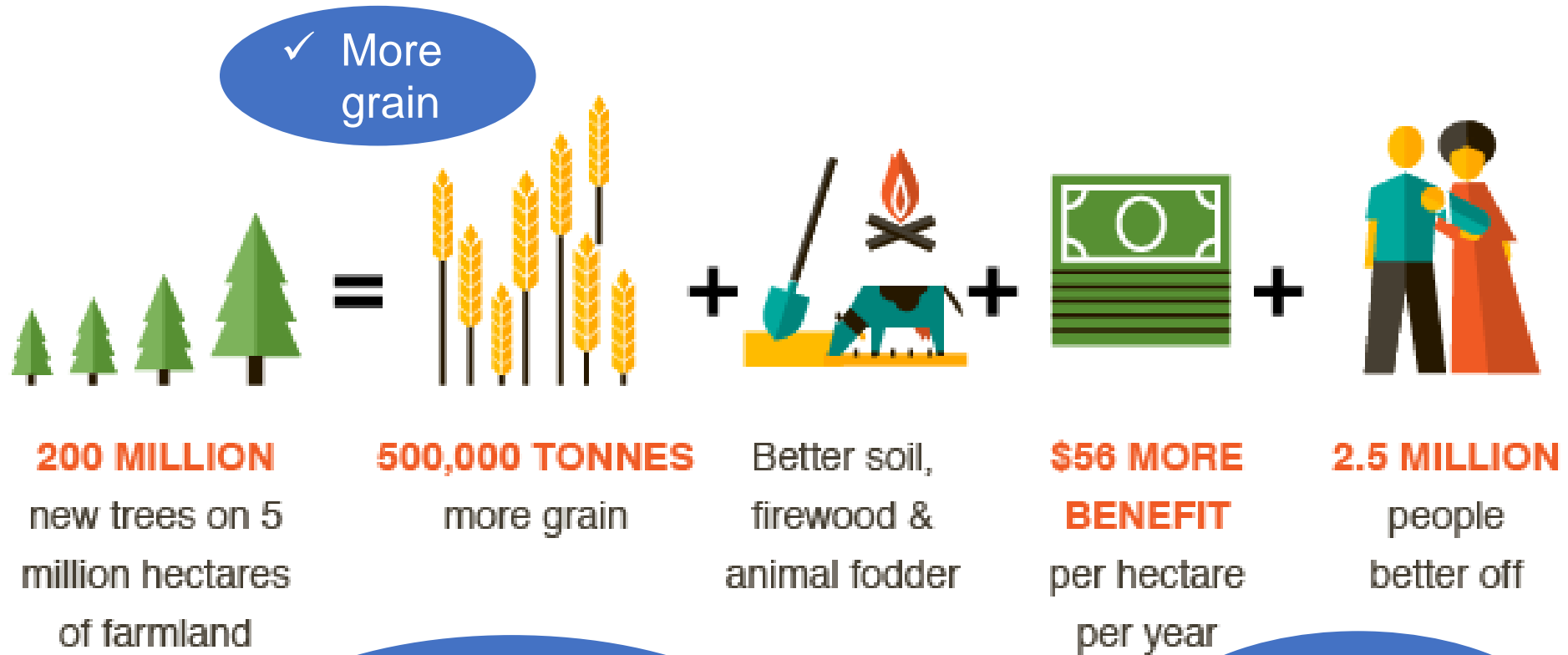
✓ 75% below 20 cm



Fisher et al. 1994, 2007



# Bringing back Sahel's Underground Forest



✓ Restored Soils  
✓ Sequestration of carbon in soils and trees

✓ Reduces drought impacts



# Irrigation – unexplored opportunity

✓ Increase, stabilize, diversify production

✓ Climate resilience

✓ 60% increase in soil carbon?!\*

Irrigation is a major policy initiative in African Nations, embedded in CAADP

\*temperate system, native sagebrush to irrigated pasture  
Entry, Soika, Shewmaker  
2002



# Urban-rural waste recycling – answer to the missing nutrients?

Figure 2 from A L Thebo et al 2014 Environ. Res. Lett. 9 114002



Thebo, Drechsel and Lambin 2014

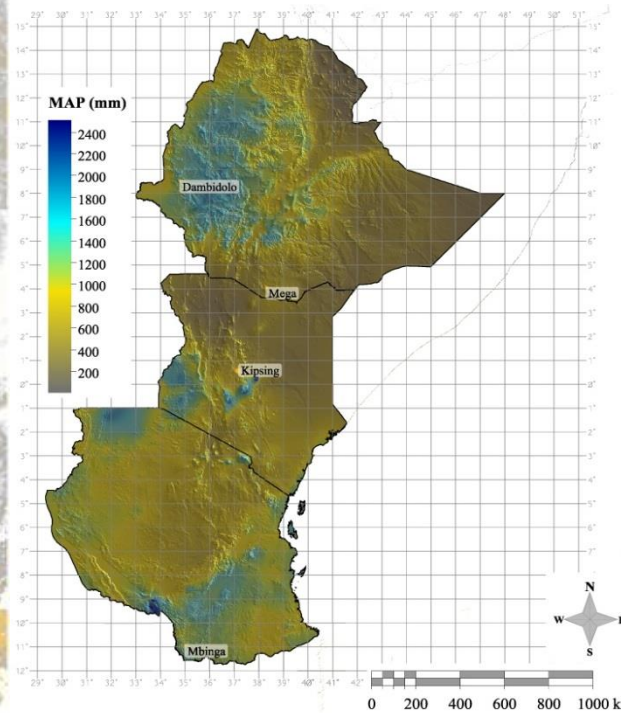
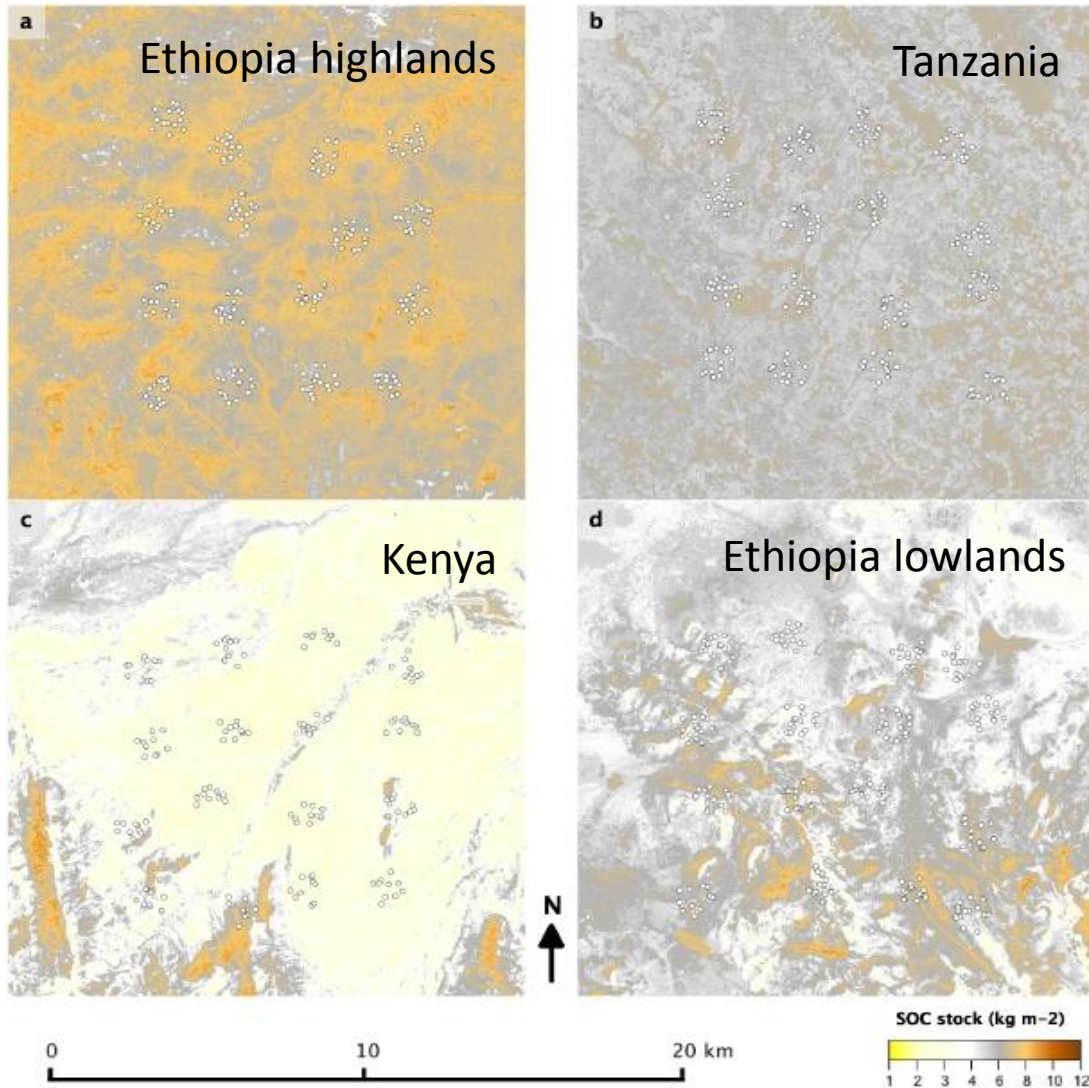
✓ Peri-urban food production

✓ Climate resilience

✓ ??% increase in soil carbon

- 456 million hectares of land, 11% of irrigated and 5% of rainfed croplands, are within 20 kilometers of cities
- Waste water a gigantic source of nutrients or gigantic pollution problem

# Soil Organic Carbon measuring and monitoring – huge progress already

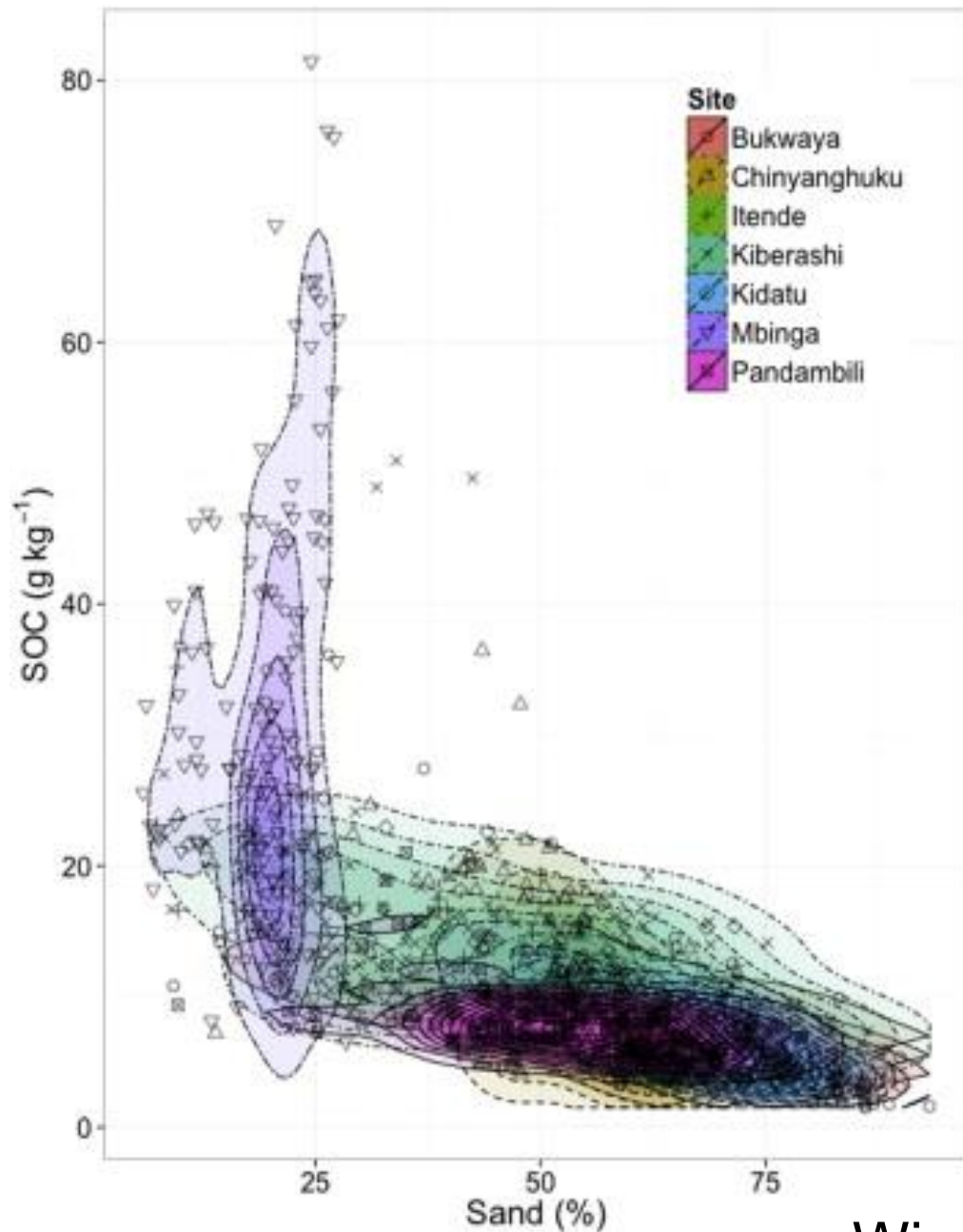


East Africa

- Land Degradation Surveillance Framework
- Field based, infrared, ensemble prediction models
  - 30 m resolution, 30 cm depth
  - Repeatable and robust across wide range of climate and land use

Vågen and Winowiecki 2013

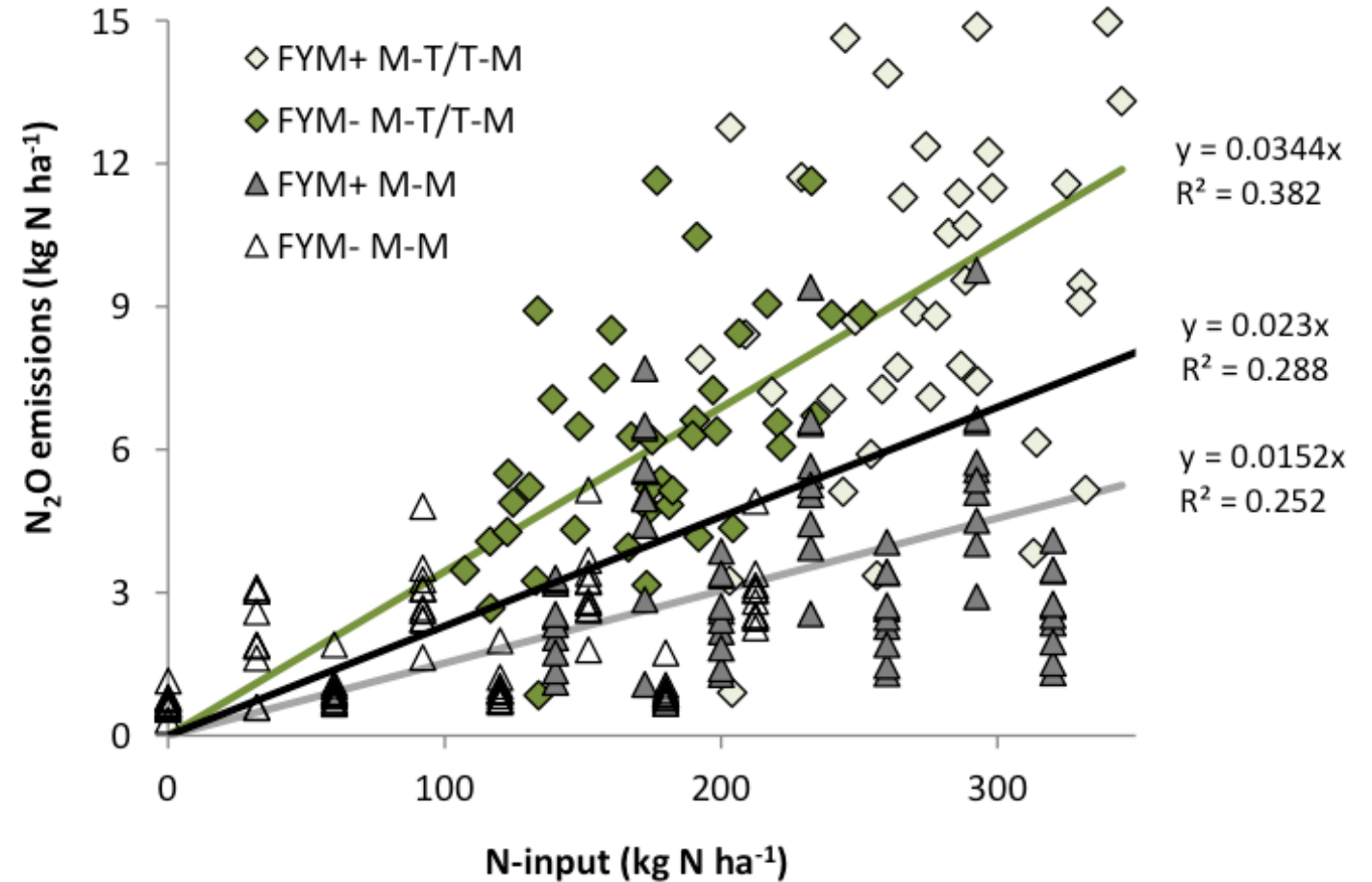
## Soil Organic Carbon dynamics in tropical soils -- still a lot to learn



- SOC lower with more sand and with cultivation (as expected)
- But not always - in one site SOC was higher in cultivated plots than non cultivated
- Site with low sand the range of SOC very high
- 2000 soil samples from 7 different sites in Tanzania

# Soil organic carbon and mitigation - difficult questions

- N<sub>2</sub>O emissions increase under practices that boost SOC
- Permanence of sequestered carbon
- Sequestration of nutrients, N, P, K etc.
- .....



# Perhaps the biggest concern is that 'soil carbon farming' may threaten rather than strengthen food security, by reducing small holders access to natural resources

In a recent review of REDD projects, project design often denied access to women because they had i) did not have secure land tenure ii) were unable to participate in meetings iii) projects strengthened men's rights to land.

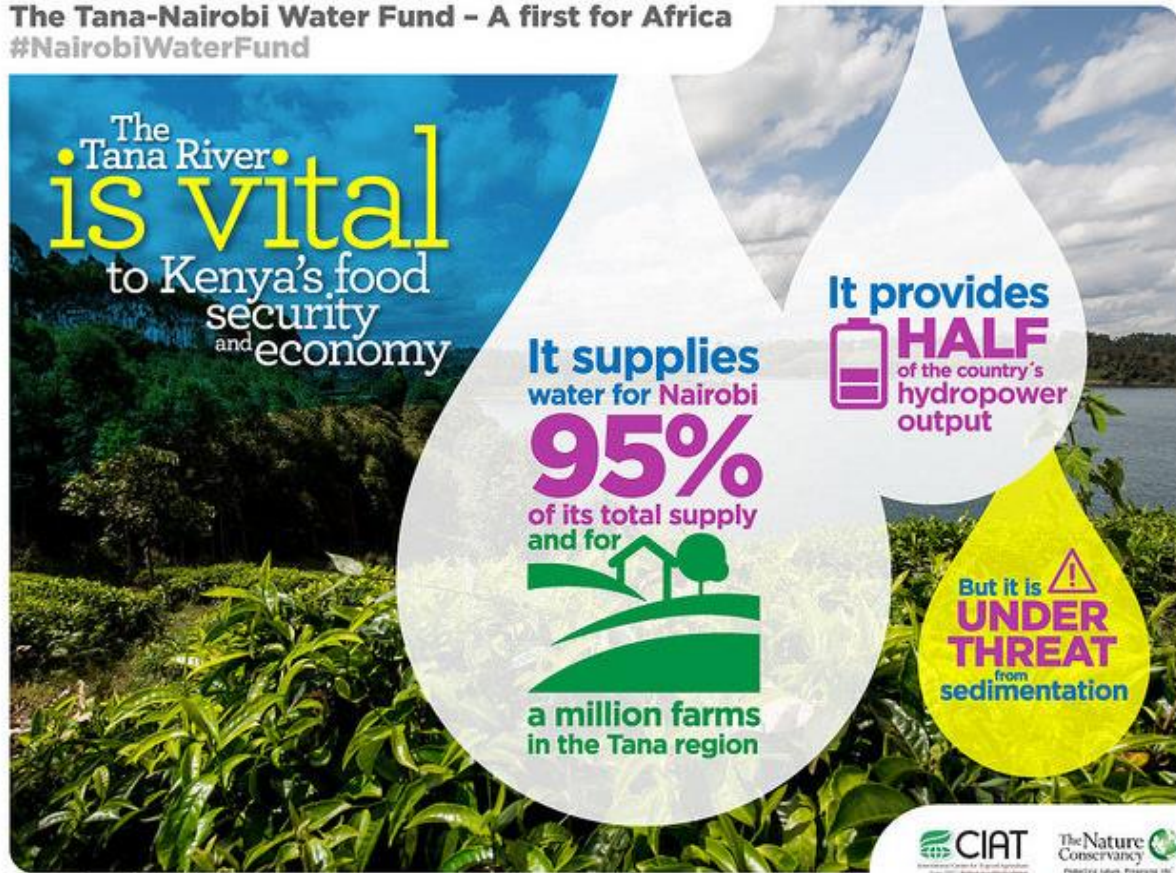
Lee et al. 2015

Rapid rise in foreign land acquisition driven in part by increased value of land attracting private investment funds, often represent a de facto shift in land and water rights from local to foreign users.

Bossio et al. 2012

Many civil society organizations raised concerns over the Global Alliance for Climate Smart Agriculture, in part due to lack of social safeguards.

Climate Smart Agriculture Concerns 2014



“Payments for Environmental Services (or PES) is rapidly emerging as a policy option in Africa to reward farmers who adopt better environmental practices.”  
CCAFS & EcoAgriculture Partners 2010

# Institutional mechanisms for benefit sharing offer solutions



# Policy Agenda + Research Agenda

## Policy Agenda

Soil Organic Matter

for food

for energy

for clean water

for climate change mitigation



## Research Agenda

Soil Science + Institution Building

for soil carbon vulnerability

for designing interventions

for setting targets

for measuring and monitoring

for benefit sharing

Initiative of the French INRA, CIRAD, IRD and the CGIAR Programs



RESEARCH PROGRAM ON  
**Climate Change,  
Agriculture and  
Food Security**



**Research  
Program on**  
Water, Land and  
Ecosystems



# **SOIL Organic Matter for Mitigation**

**= SOIL FERTILITY**

**= PRODUCTIVITY**

**= FOOD SECURITY**

Does the equation  
work?

You decide.



# THANK YOU



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Science for a food secure future