Research areas of potential importance to members of the Croplands Research Group

GLOBAL RESEARCH ALLIANCE ON AGRICULTURAL GREENHOUSE GASES

1. Agroforestry systems

Adoption and adaptation of agroforestry systems across a diversity of ecoregions around the world to sequester soil organic carbon, mitigate greenhouse gas emissions, enhance soil quality, and improve agricultural resiliency

a. document successes and impediments from trials around the world

b. regional focus in tropics and temperate areas as separate teams

c. develop emission estimates from different intensity levels of systems

d. characterize emissions from various forms of silvopasture and alley cropping systems

e. determine impacts of various perennial-based bioenergy production systems on soil and water quality and greenhouse gas accounting

f. assess on-farm and off-farm flows of nutrients and energy

2. Conservation agriculture

Adoption and adaptation of conservation agricultural approaches for crop production across a diversity of ecoregions around the world to sequester soil organic carbon, mitigate greenhouse gas emissions, enhance soil quality, and improve agricultural resiliency

a. focus on successes and impediments from trials around the world

b. create a database of research findings to provide evidence for storage of soil organic carbon and reductions in greenhouse gas emission intensity

c. create network of logistical support

d. develop long-term research sites in less developed countries

e. identify regions of greatest resistance to change

f. develop strategies for overcoming barriers

g. promote best practices

3. Integrated crop-livestock systems

Develop networks of research to better understand the impacts of integrated systems to store soil organic carbon and reduce greenhouse gas emissions

a. **document successes and impediments from trials around the world**
b. **determine effects of pasture-crop rotations on soil carbon storage**
c. **develop understanding of potentials for grazing cover crops in croplands under different environmental and soil conditions**
d. **address impacts on agricultural resiliency with systems as compared with mitigation and adaptation foci of systems**

4. Integrated nutrient management

Develop knowledge base to reduce reliance on external fertilizer inputs by accounting for all organic and recycled sources of nutrients within a farming system

a. **determine extent of animal manure and other organic amendments available in a region**

b. **determine impact of organic amendments on soil C sequestration in a systematic manner across diversity of environments in long-term studies**

c. **define impacts of grain and forage legumes in crop rotations and biochar application on nutrient transformations and GHG emissions**

d. **create a network of researchers to assemble information into a shared database on soil C sequestration and GHG emissions**

e. **assess impact of combined organic and inorganic fertilization strategies on long-term agricultural production and resiliency**

f. **test N fertilizer rate, placement, timing, and formulation on N_2O emissions under diversity of environmental, soil, and management sites**

5. Irrigation efficiency

Address issues of agricultural sustainability under irrigated agricultural conditions with greenhouse gas emissions assessment, soil and water quality evaluation, resource-use efficiency, and food security

a. **assess irrigation use and opportunities for efficiency within ecoregions**

b. **develop networks for sharing knowledge and creating impacts of interventions**

c. **determine opportunities for greenhouse gas emissions intensity reduction and soil carbon sequestration in different regions with limited and full irrigation strategies and modes of water delivery**

6. Landscape management of agricultural systems

Create a knowledge framework for understanding the spatial and temporal aspects of soil carbon and greenhouse gas emissions within particular landscapes

a. **draw on recent examples of successes from landscape approaches around the world**

b. **create database of management issues of greatest concern within a region to assess impacts on soil C sequestration, environmental footprint, soil quality improvement, and agricultural resiliency**

c. **understand the human/social dimensions in the context of biophysical GHG emission accounting**

7. Modeling of carbon and nitrogen fluxes in diverse agroecosystems

Implement a modeling approach to quantify greenhouse gas fluxes from farming systems with a diversity of input and production levels to better assess potentials for reducing greenhouse gas emission intensity

- a. validate DNDC, DAYCENT, and other process-based models against field trials
- b. compare simpler index approaches with process-based models to reach a wider audience
- c. calibrate GHG emissions with ecosystem index parameters to identify promising management approaches at a local level

8. Peatland management

Develop strategies to limit peatland organic C loss and reduce GHG emissions in boreal, temperate, and tropical regions

a. **develop systematic monitoring approach to assess current conditions and potentials for change**

b. **determine loss rates under different environmental and management conditions**

c. **create a dedicated, long-term research network across a diversity of environments**

d. **assemble historical data into network database**

e. **link research findings with policy decisions**

9. Small-farm resource management

Develop farm-level carbon accounting systems and energy flow diagrams for improved understanding of issues facing small-scale farmers so that successful interventions can be implemented to achieve greater resource efficiency

a. **categorize levels of farm complexity**

b. **associate GHG emissions with practices and whole systems**

c. **test efficacy of generic models in complex farming systems and develop improved components of these models**

d. **develop networking opportunities to guide advanced developments**

10. Other areas of concern?

…

a. …

Volunteers for individual committees:

Email request made 22 April 2015

- **Rod Venterea (USA)** – N_2O emissions
- **Peter Grace (Australia)** – modeling
- **Upendra Sainju (USA)** – conservation agriculture and integrated nutrient management
- **Maria Jose Alonso Moya (Spain)** – general
- **Roberta Farina (Italy)** – conservation agriculture and integrated nutrient management
- **Xunhua Zheng (China)** – crop residues in rice, nitrification inhibitors
- **Jens Leifeld (Switzerland)** – peatland management, modeling
- **Sheilah Nolan (Canada)** – integrated crop-livestock systems
- **Steve Del Grosso (USA)** – model validation
- **Alan Franzluebbers (USA)** – integrated crop-livestock systems, conservation agriculture, agroforestry systems, general
- **Others?**

Resources

- Greenhouse gas mitigation options and costs for agricultural land and animal production within the United States, ICF International for USDA Climate Change Program Office, February 2013, 270 pages
- Regional approaches to climate change for Pacific Northwest agriculture: Climate science northwest farmers can use, Regional Approaches to Climate Change – Pacific Northwest Area, February 2015, 146 pages
- Smith et al. 2008. Greenhouse gas mitigation in agriculture. Phil. Trans. R. Soc. B 363, 789–813
- Eagle et al. 2012. Greenhouse gas mitigation potential of agricultural land management in the United States: A synthesis of the literature. Report NI R10-04, Third Edition. Durham NC, Duke University

Croplands Research Group Greenhouse Gas Mitigation Summary 01

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Title

- e.g. How animal manures contribute to and assist in mitigation of greenhouse gas emissions from croplands

What is the issue?

- general statement of interest, define terms, relevance of practice/system/issue to particular crops, regions, resources available, etc.

What are the factors controlling responses?

- review of factoring controlling responses of interest - SOC, CO_2, N_2O, CH_4

What are expected responses?

- describe generalities of response and list exceptions by region, environmental conditions, etc.; likely to be the largest section but it should be kept to <2 pages; overall summaries or specific examples from targeted research projects would be appropriate; try to use examples that are consistent across studies

How can research help in refining mitigation estimates?

- describe current and future research needed and highlight need for international collaborations; who are partners that are and could assist in this research?

Synthesis / recommendations

- summarize current state of knowledge to make projections globally or regionally

Acknowledgements

- list contributors, references, sources of additional information on the topic, etc.

Example:

How integrated crop-livestock systems can mitigate GHG emissions and improve adaptation to climate change through soil organic C sequestration

Background

1. **Integrated crop-livestock systems (ICLS) represent a diversity of agricultural approaches used for various reasons, but which can be characterized as mixing cropping with animal production aspects.**

2. **Climate change can affect ICLS similar to that of specialized agricultural systems, but mixed production systems offer some alternatives to both mitigate and adapt to climate change, resulting in potentially less severe devastating effects on farm- and national-scale agricultural production outcomes.**

Adapted from

8 Climate Change and Integrated Crop–Livestock Systems in Temperate-Humid Regions of North and South America: Mitigation and Adaptation

Alan J. Franzluebbers

USDA – Agricultural Research Service, Raleigh, North Carolina, USA

Table 8.1. Characteristics of specialized and integrated agricultural systems.

Specialized agricultural systems, based on considerations of:	Integrated agricultural systems, based on considerations of:
○ Climate	○ Climate
○ Socio-economics	○ Socio-economics
○ Infrastructure	○ Infrastructure
○ Markets	○ Markets
	○ Natural capital
➢ Leading to a focus typically on the most profitable system possible without high regard to other factors.	○ Environmental impacts
➢ Most often a traditional system that fits the climate/infrastructure domain of a region without high regard to environmental factors.	➢ Leading to diverse agricultural enterprises to balance production and economic gains with minimal negative influence on the environment.
	➢ Typically, systems that rely on natural capital rather than purchased capital to maximize resource efficiency.

Rationale

4. **Production concerns of modern, industrial systems of**
    - **farms operating on marginal profit**
    - **economic vulnerability with specialized production**
    - **high cost of fuel and nutrients**
    - **pests greater with monocultures**
    - **yield decline could be overcome with rotation**
5. **Some environmental incentives for integrated crop-livestock systems are**
    - **nutrient recycling could be improved in both crop and livestock systems**
    - **conservation of soil and water are more easily possible with sod-based management systems**

Types of integrated crop-livestock systems

6. **Sod-based rotations represent a diversity of proven systems to maintain yield, reduce pest incidence, and help protect environmental quality in a wide range of climatic and edaphic conditions. Rotations may be**
   - **short – annual cover crops**
   - **intermediate – biennial legumes planted with a small-grain nurse crop and harvested for forage the following year followed by planting of grain crops**
   - **long – perennial forages planted following row crops and harvested for forage by grazing, haying, or silage during several years until rotated to cash crops again. Longer rotations generally enhance soil organic C sequestration, improve soil quality, and foster deeper deposition of C**

Types of integrated crop-livestock systems

7. **Grazing cover crops**
8. **Dual-purpose use of small grains**
9. **Grazing crop residues**
10. **Integrated crop-livestock-woodlands**
11. **Pasture cropping**
12. **Regional integration**

Tables and figures of how systems affect soil organic C and GHG emissions

Integrated crop-livestock systems as a strategy for climate change adaptation

Prospects for developing greater resilience to climate extremes