ARS NP212 CLIMATE CHANGE, SOILS & AIR EMISSIONS PROGRAM UPDATE

CHARLIE WALTHALL, JORGE A. DELGADO AND STEPHEN (STEVE) DEL GROSSO
* ARS NP212 CLIMATE CHANGE, SOILS & AIR EMISSIONS PROGRAM UPDATE

* REAP/GRACENET DATABASE PROGRESS REPORT

* REACTIVE NITROGEN

* NEW NITROGEN INDEX
ARS NP212 CLIMATE CHANGE, SOILS & AIR EMISSIONS PROGRAM UPDATE

- Retrospective Review – end of 5 year research cycle
  - Document: Executive Summary
    - vs Catalog of results
  - Power point presentation
  - Stakeholder webinar workshop Dec. 3, 2014
  - Program Review Panel at later date

- Natural Resources & Sustainable Agriculture Programs Reorganization
  - Due to changing priorities
  - For better project alignments
  - Because of fewer National Program Leaders (NPL) & assistants
    - At least 2 new NPL hires approved
ARS NP212 CLIMATE CHANGE, SOILS & AIR EMISSIONS PROGRAM UPDATE - 2

- NP212: Soils & Emissions
  - Soils research
  - Air quality research – Air Quality Researchers Working Group
    - Including Animal systems, manure
  - GRACEnet & Livestock GRACEnet
  - REAP – will focus on soil health/sustainability
    - Renewable Economic Agricultural Practices
- Future Activities
  - USDA-EPA Ammonia Research Group
  - New Soil biology working group
  - Soil Health partnership with NRCS
  - Rangeland Wind Erosion working group
  - Data stewardship: ARS –wide (“Big Data”)
    - Internet-2 lines
    - More computing power
ARS NP212 Climate Change, Soils & Air Emissions Program Update - 3

- **New ARS NP212/Air Quality NPL – to be hired**
- **Charlie Walthall moving to NP216 – Sustainable Systems Program**
  - Genetics x Environment x Management interactions emphasis
  - More cross-disciplinary research projects

Thank you to all my friends & colleagues of the past & present AAQTF teams.

-Charlie

P.S. I got married October 10!
REAP/GRACENET DATABASE PROGRESS REPORT
Evaluate soil C status & change
Determine net GHG emission (CO₂, CH₄ and N₂O)
Determine environmental effects (water, air and soil quality)
Progress Highlights

- Data Entry Template improvements
- More contributors - currently 34 units
- More data contributed
- Model results as well as experimental data
- Enhanced GIS and visualization
- Integration of REAP and GRACEnet into USDA ARS data portal

http://nrcc.ars.usda.gov/arsdataportal/#/Home
http://nrcc.ars.usda.gov/dpasa/#/Home
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Data at Fort Collins, CO SPNR for Table Measurement GHGFlux and Unit COARDEC_ardecUAN+AgroT20ZNT
* REACTIVE NITROGEN
Figure 13. Effect of N fertilizer rate applications on yield and N uptake by irrigated corn (Adapted from Bock and Hergert, 1991). Potential N available to leach (NAL) assuming major pathway for losses is leaching. The NAL was estimated as NAL = N applied – N uptake.

Delgado 2004
US Inventories

- Environmental Protection Agency – submitted annually to the UNFCCC
- US Department of Agriculture – compiled every 3 years

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Note: Parentheses indicate a net sequestration. Tg CO₂ eq. is teragrams carbon dioxide equivalent; CH₄ is methane; N₂O is nitrous oxide; CO₂ is carbon dioxide.

¹ Soils Indirect N₂O emissions account for volatilization and leaching/runoff.
² Includes sources and sinks.

Greenhouse gas emission from agricultural soils, primarily N₂O, were responsible for the majority of total emissions, while CH₄ and N₂O from residue burning and rice cultivation caused about 4% of emissions in 2008 (Tables 3-1, 3-2). Soil CO₂ emissions from cultivation of organic soils (15%) and from liming (2%) are the remaining sources. Nitrous oxide emissions from soils are the largest source in the U.S. because N₂O is a potent greenhouse gas (see Chapter 1 Box 1-1) and due to the large amounts of nitrogen added to crops in fertilizer that stimulate N₂O production. Emissions from residue burning are minor because only ~3% of crop residue is assumed to be burned in the U.S. (EPA 2010). Cropped soils in the U.S. are a net CO₂ sink mainly because reduced tillage.
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About 20%
Nitrogen Trends in U.S. Rivers
1993 - 2003

- Red triangle: Increasing
- Blue triangle: Decreasing
- Grey circle: No change
Nitrate Trends in the Mississippi River
1980-2010

△ Increasing

△ Decreasing

○ No change

Gulf of Mexico
Tier 3 Results – Direct Soil N$_2$O Emissions

Total: 208.0 $\pm$48/-33% Tg CO$_2$ eq. yr$^{-1}$

*Del Grosso et al., 2010, Global Biogeochemical Cycles*
US National Resources Inventory (NRI): Point-Based Survey

Data

Source: US Dept. of Agriculture
averaged across three studies

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Controlled-Release Fertilizer Can Increase Yields of Continuous No-till Irrigated Corn

Jorge A. Delgado¹, Ardell Halvorson¹, Steve Del Grosso¹, Daniel Manter¹, and Catherine Stewart¹

¹USDA-ARS Soil Plant Nutrient Research Unit, Fort Collins, CO 80526

We established six N treatments with rates varying from 0 to 224 kg N ha⁻¹ to test urea and controlled-release, polymer-coated urea (ESN).

The ESN treatments included 34 kg urea-N ha⁻¹ as a starter.

The treatments were applied to irrigated no-till corn grown in continuous corn (CC) (Zea mays L.) and corn-dry bean (Phaseolus vulgaris L.) (CB) rotations.

Nitrogen fertilizer increased yields of corn (P<.0001).
Controlled-Release Fertilizer Can Increase Yields of Continuous No-till Irrigated Corn

The average yields with ESN in CC (9.4 Mg dry grain ha\(^{-1}\)) were higher than with urea (8.8 Mg dry grain ha\(^{-1}\)) (P<.08).

There was no difference in yields between ESN and urea with the CB.

Data suggest that at $4.00 per bushel for corn and a 25% higher cost for the ESN, the ESN could potentially be a viable, economical source for CC.
2010 and 2011

All N sources were applied at a rate of 202 kg N ha$^{-1}$.

2014
(at 246 kg N ha)

CC - ESN, 13.4 Mg dry grain ha$^{-1}$ > CC – urea, 12.1 Mg dry grain ha$^{-1}$ (P<.08)

(Preliminary)
additional studies are needed
* NEW NITROGEN INDEX
Use of the new Nitrogen Index tier zero to assess the effects of nitrogen fertilizer on N2O emissions from cropping systems in Mexico

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a USDA-ARS, Soil Plant Nutrient Research Unit, 2150 Centre Avenue, Building D, Fort Collins, CO 80526, United States
b Colegio de Postgraduados, Laboratorio de Fertilidad de Suelos y Químico Ambiental, Texcoco, Mexico
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ARTICLE INFO
Article history:

ABSTRACT

Mexico is one of the largest users of N fertilizer in the world, and the 2nd largest user in Latin America.
Fig. 6. The N$_2$O emissions estimated by the Nitrogen Index tier zero tool for wheat and maize crops in Mexico versus measured N$_2$O emissions values from the field.
**Fig. 8.** The aboveground crop N uptake estimated by the Nitrogen Index *tier zero* tool for wheat and maize crops in Mexico versus measured N uptake.
Fig. 9. The system nitrogen use efficiency estimated by the Nitrogen Index tier zero tool for wheat and maize crops in Mexico versus measured N fertilizer use efficiency.
Development and testing of a new phosphorus index for Kentucky


Abstract: The phosphorus index (PI) is a field-scale assessment tool developed to identify fields most vulnerable to phosphorus (P) loss. The USDA Natural Resource Conservation Service (NRCS) recently revised its 590 Nutrient Management Standard and Title 190 National Instruction requiring that all NRCS-approved PI tools meet certain criteria. A recent study evaluating the Kentucky PI showed that it did not meet several of the criteria established by NRCS. This paper describes the development and evaluation of a revised PI for Kentucky in response to the revised 590 Standard. Important revisions to the Kentucky PI include (1) use of a component formulation, (2) incorporation of erosion and P application rates, (3) use of continuous variables, and (4) use of empirically based weighting factors. The revised Kentucky PI was evaluated against measured P loss data reported in the literature. Output from the revised PI was well correlated (Spearman’s ρ = 0.86; p < 0.001) with the measured P loss data. Results also indicated that the revised Kentucky PI correctly assigned the appropriate risk category to the majority of fields with P loss values below or above our predefined cutoff values for low and high risk fields. On the other hand, the revised PI only correctly categorized 43% of the fields deemed to be at moderate risk. To assess whether the revised PI provided improved estimates of P loss risk, output from both the original and revised Kentucky PIs was compared against a P loss data set collected in the southern United States. Results indicated that the revised PI (PI_revised) performed better than the original PI (PI_original).

As each state adapted the PI framework to reflect local conditions and priorities, important state-to-state differences in PI structure have resulted. These differences include what factors are incorporated into the PI, how each factor is weighted, how the final PI value is calculated, the scientific rigor of the PI, and how PI values are interpreted in relation to P management planning (Osmond et al. 2006; Osmond et al. 2012; Sharpley et al. 2013; Sharpley et al. 2003; Weld and Sharpley 2007). Such diversity in PI formulations can result in significant variability in PI ratings and recommended P-based nutrient management planning strategies for similar field and land management conditions (Benning and Wortman 2005; Osmond et al. 2006; Osmond et al. 2012). This has led to criticism of the PI approach for evaluating P loss risk and has led to calls for a more standardized approach to PI development across states. Moreover, there is growing concern about the lack of improvement in water quality despite implementation of the PI as a risk assessment tool, particularly in the Chesapeake Bay (Executive Order 13508 2009; Kovzelove et al. 2010). The USDA NRCS, in cooperation with a working group of scientists within the Southern Farm Bill Action Group (SBAG),
Figure 6
Example output from combined phosphorus (P) and nitrogen (N) index graphical user interface. In this example, $3.7 \times 10^4$ L ha$^{-1}$ of liquid swine manure was applied to a soil with a curve number of 86 (hydrological soil group D), soil test P of 104 mg kg$^{-1}$, and an annual erosion rate of 2,240 kg ha$^{-1}$. 