Investigation of Benefits from Organic Management Alternatives Using DNDC Model Simulations for Developing Sustainable Practices in Texas Rice Production.

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Introduction

- Delineating a holistic set of sustainable practices catered toward the welfare of farmers and the local community has become critical for maintaining and enhancing soil ecosystem services.
- Organic rice production management options need to be evaluated and compared to conventional systems.
- The Denitrification and Decomposition (DNDC) model has accurately simulated rice ecosystem emissions to predict long-term benefits from rice management strategies in Japan and China (Fumoto et. al., 2008; Zhao et al., 2016)
- Organic and conventional rice production systems were compared using DNDC simulations
- The DNDC model was optimized and verified against data from a greenhouse trial conducted in 2015 using hybrid cultivar XL753 and 6 N rates of Urea and manure
- Factors of variation studied:
  - Methane emission
  - Grain yield
  - Soil organic carbon levels

Results and Discussion

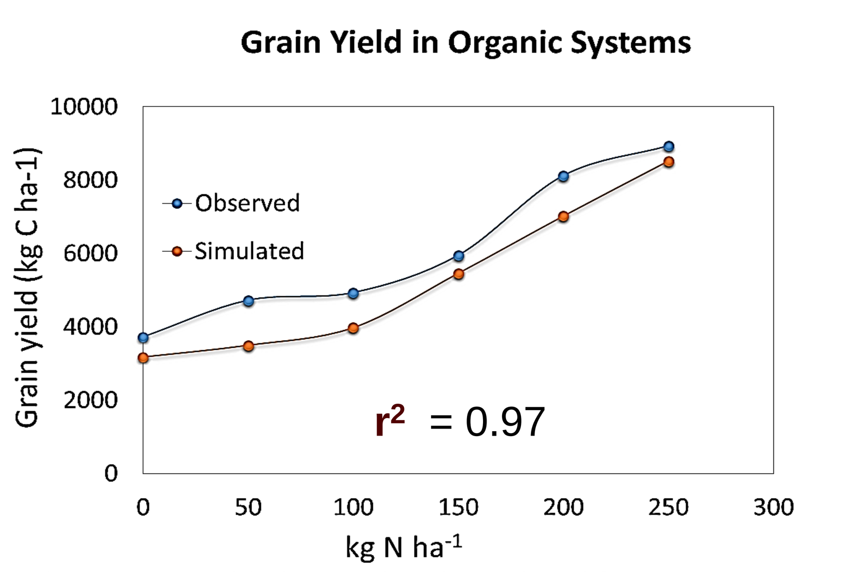


Fig 2. Grain yield observed and simulated for organic system using manure as N source

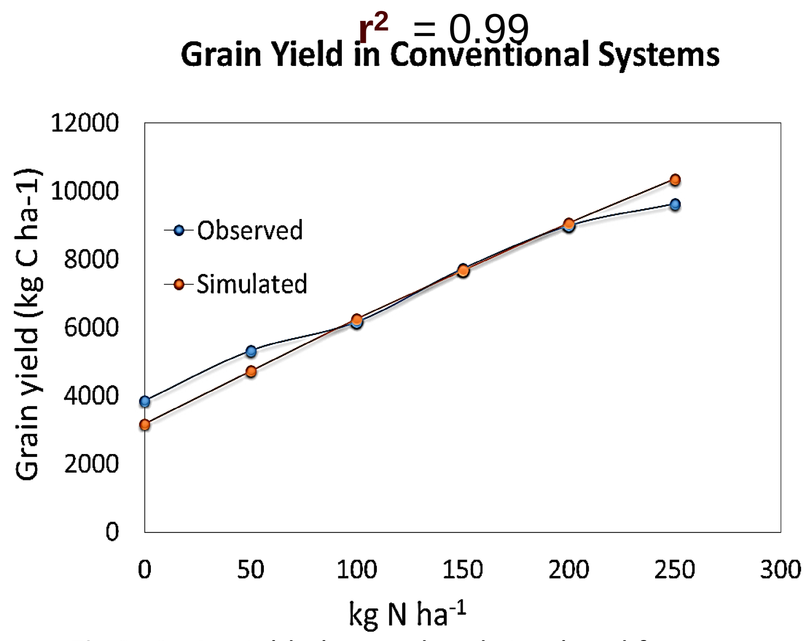


Fig 3. Grain yield observed and simulated for conventional system using urea as N source

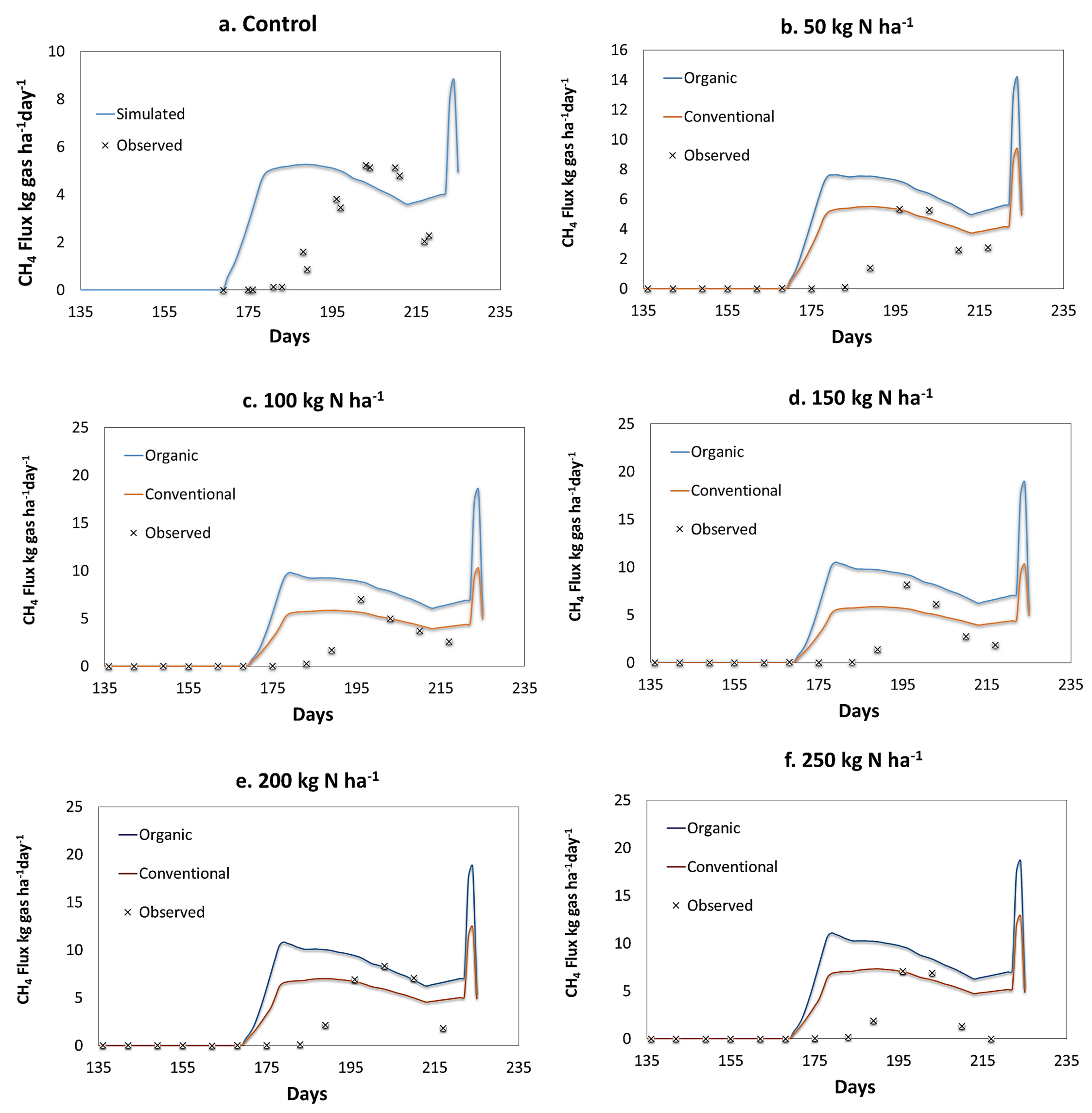


Fig 7. Modeled and observed methane emissions from the organic and conventional systems and observed flux from the greenhouse study for: a. 0 (control) ; b.50; c.100; d. 150 ; e. 200 ; and f. 250 kg N ha^{-1}

- **Methane emission** is consistently higher for the Organic compared to the Conventional Systems (Fig 7.)
- Control had the lowest emissions (Fig 7.)
- Manure provides additional source of carbon in the system

- **Soil Organic Carbon** increases with increase in manure application (Fig 4.)

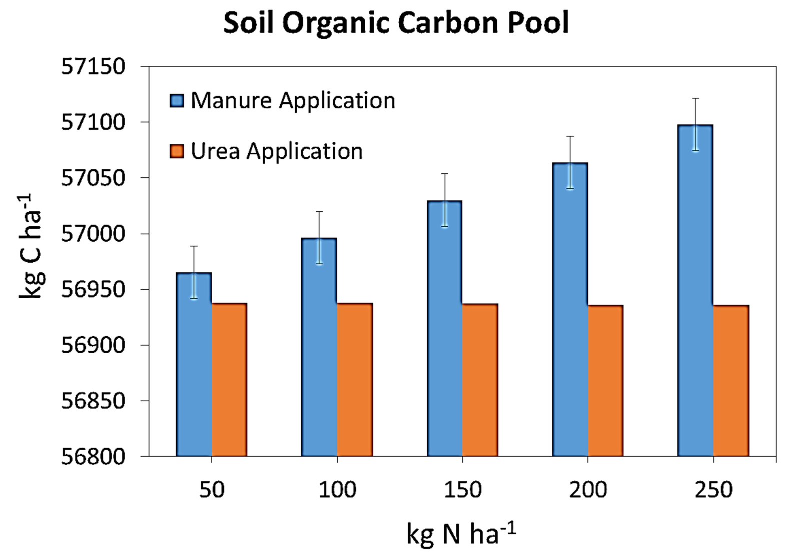


Fig 4. Soil Organic Carbon values post harvest

Organic Rice Ecosystem Services Concepts

- Linking **Natural Capital** with **Socio-Ecological Capital** (Fig 6.)
- Linking **indicators** Identified: Soil N concentrations, SOC content, Soil Eh (Fig 6.)
- **Ecosystem Services**: provision of food, provision of raw materials and filtering of nutrients (Fig 6.)
- **Benefit Transfer Mechanism**: marketable product yield, yield factor of available cultivable land and cost reductions from reduced fertilizer input (Fig 6.)

Research Objectives

1. Assess the benefits of organic versus conventional systems for rice production in Beaumont, Texas

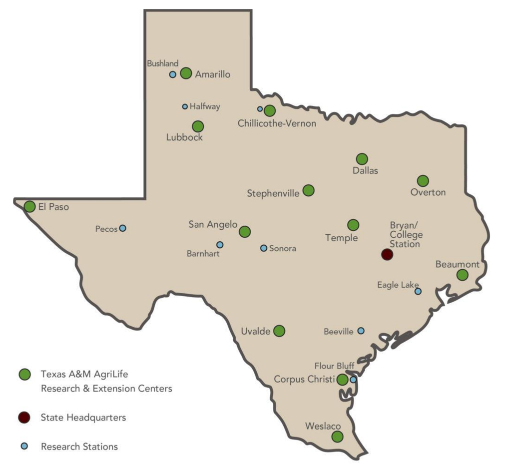
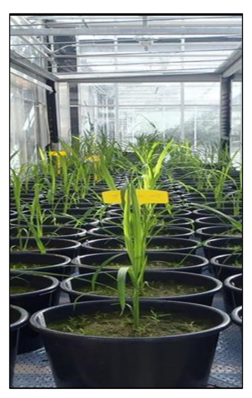


Fig 1. Map of Texas A&M Agrilife Extension sites and Beaumont, TX.

2. Compare fluctuations in methane emissions between organic and conventional rice production systems using six application rates of fertilizer and manure each
3. Predict the capacity of carbon sequestration based on the soil organic carbon pool (non-labile) and evaluate its net capacity as a carbon sink
4. Employ the linking indicators to evaluate the status of ecosystem services from adopting the organic sustainable alternatives



Organic source of Nitrogen, Nature Safe (*left);* Conventional source of Nitrogen, Urea (*middle*)

Material and Methods

Denitrification and Decomposition (DNDC) is a process-based model that simulates biogeochemical processes of carbon and nitrogen for agricultural ecosystems.

I. Model Optimization

- Most Sensitive Factor (MSF) analysis was used to create a range of acceptable values for maximum biomass, soil organic carbon, microbial activity index, and soil pH
- Root, stem, leaf and grain fractions were collected and analysed for total carbon and nitrogen using standardized method of analysis
- Soil total carbon and nitrogen values were determined
- Temperature and precipitation data were adjusted to fit the environment of the greenhouse over normal field trials

II. Model was verified by comparing to a 2015 greenhouse study

III. Organic Rice Ecosystem Services. A conceptual model was created (Fig. 6).

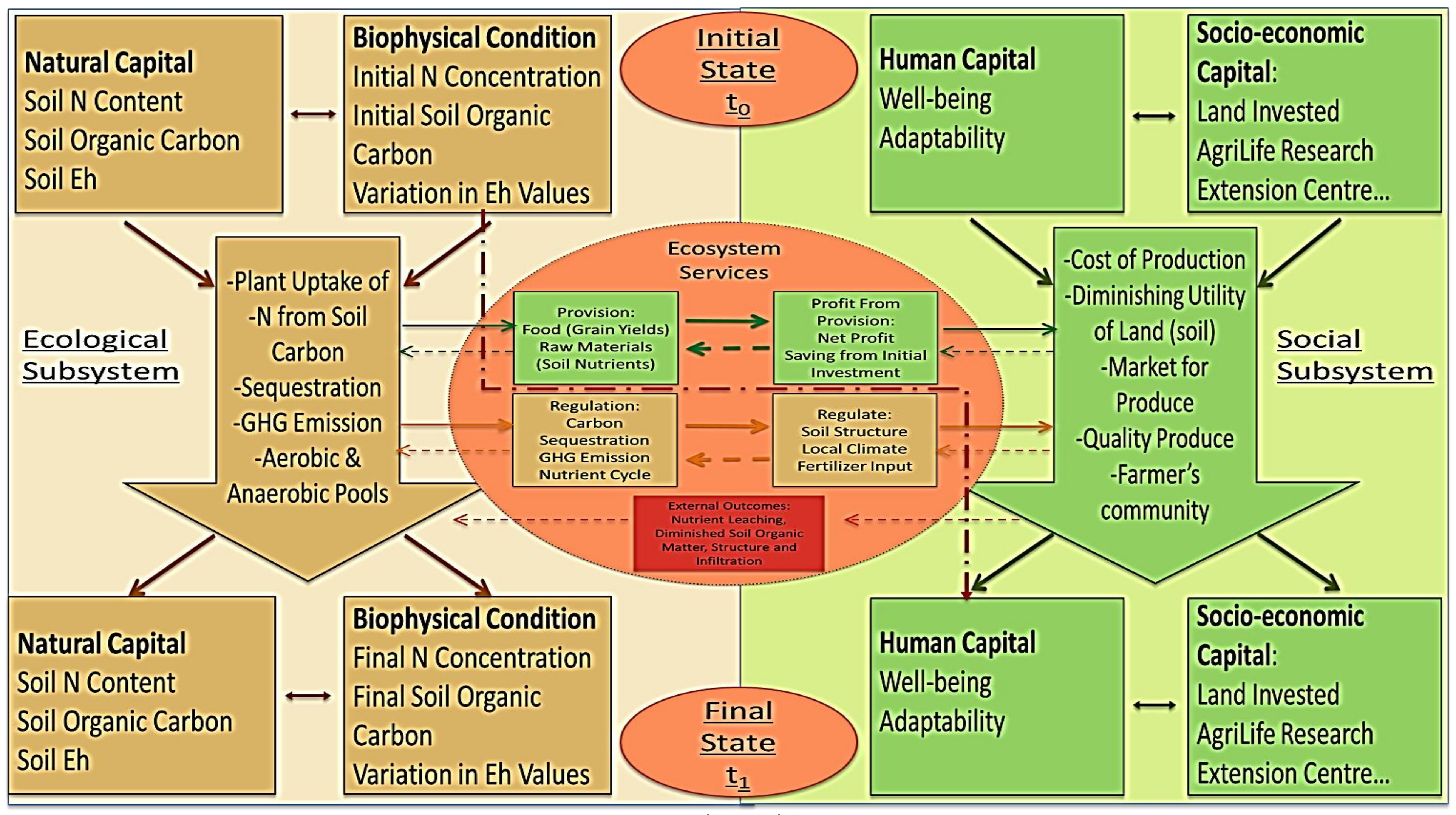


Fig. 6. Integrated Social, Economic and Ecological Concept (ISEEC) for Sustainable Rice Production

Future Research

Challenges

- Observations for CH_4 emission from the greenhouse study were not made daily due to high cost of analysis.
- Collection and compilation of data for climate inside and outside the greenhouse should include observed daily air temperature and solar radiation.
- Determination of soil microbial population to better fit the DNDC index using laboratory analysis is also a requirement

Future Research Objectives

- For future optimization of the study for Texas, field data must be collected on soil properties
- Collaboration prospective with National Institute of Agro-environmental Sciences, Tsukuba, Japan to share their version of DNDC-Rice
- Present study has the capacity to be used for a regional analysis of the Texas coastline currently being used for rice production

Acknowledgements

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Thanks, and Gig 'em!