


Introduction and main objectives in short term research of Helio Joris at ORNL"

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Overview

- **Work in progress in Brazil and goals while at ORNL**

  - **Bioen project introduction**
  - **General view of thesis work**
  - **Available data**
  - **Scope of work at ORNL**
    - **Nutrient requirements comparison**
    - **Getting data for the EPIC model**
    - **Sustainability and assessment indicators (PIRE and NSF funded projects)**
    - **Nitrogen cycle on MEND model (literature review)**

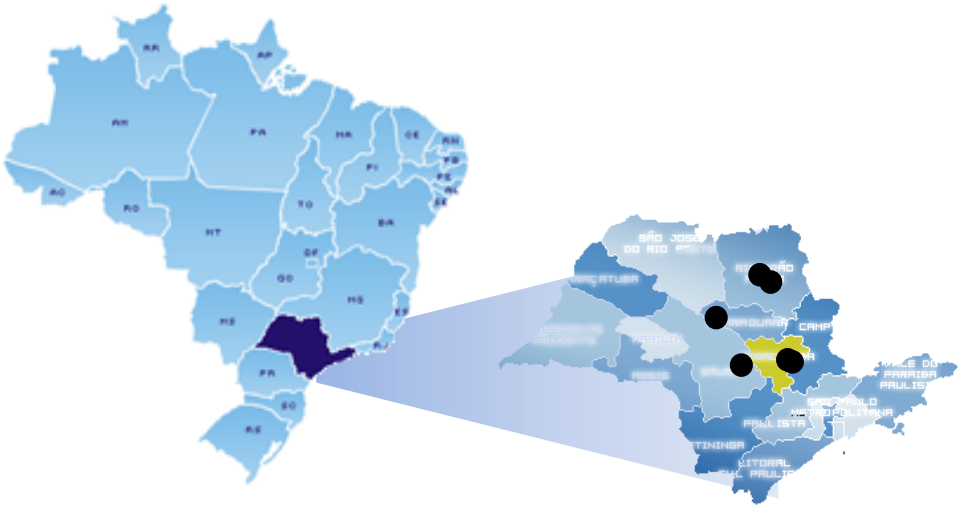
Bioen Project (Fapesp)

Thematic project coordination: Dr Heitor Cantarella

Nitrogen nutrition of sugarcane by mineral fertilizer or diazothrophic bacteria

(Fapesp 2008/56147-1)

- Several field experiments, all over Sao Paulo state, in order to evaluate the sugarcane nutrition as affected by variety, mineral fertilization and diazothrophic bacteria inoculation.



Bioen Project (Fapesp)

Current situation: At least two cycles of sugarcane were completed in 6 field areas

Available data:

Nitrogen (N)	→	Total uptake
Phosphorus (P)	→	Removal from the field (stalks)
Potassium (K)	→	Dynamics in the soil-plant-system
Calcium (Ca)		
Magnesium (Mg)		
Sulfur (S)	→	N use efficiency (15N studies)

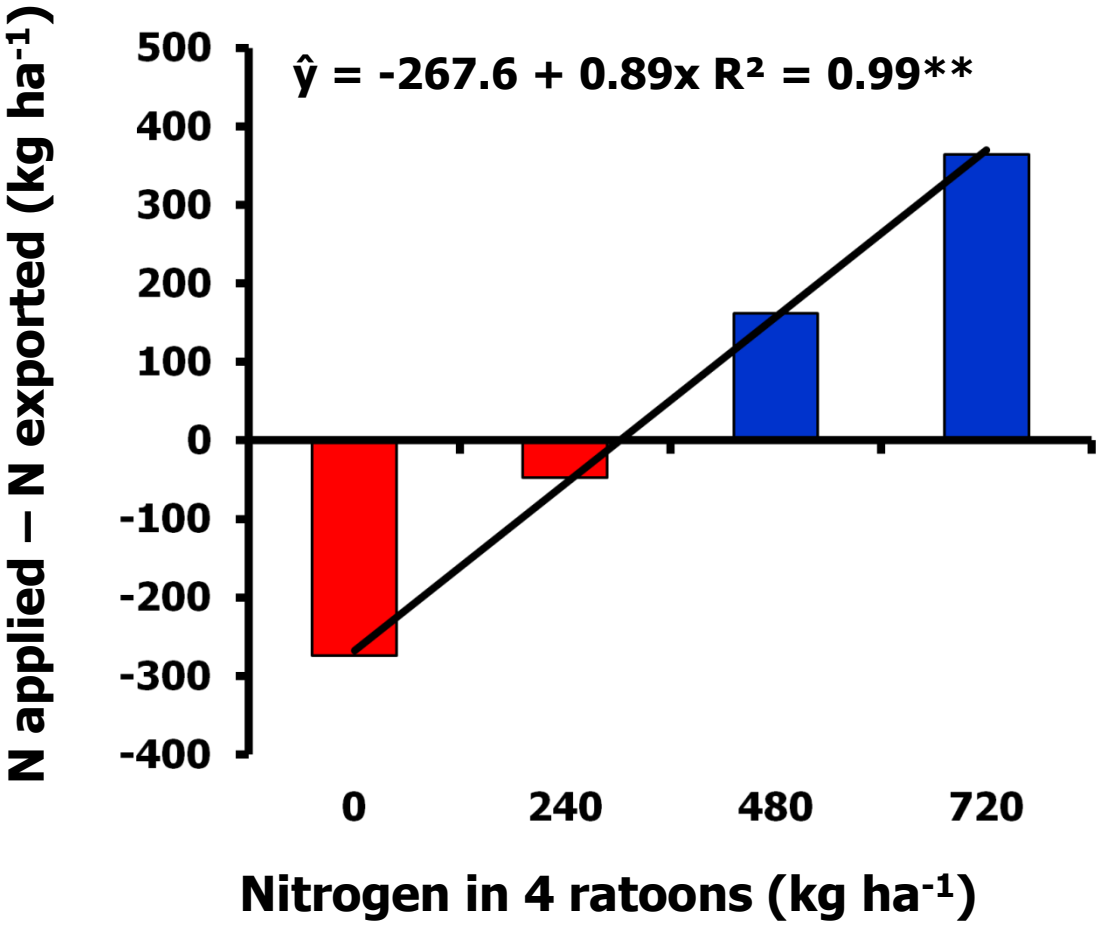
- Stalk and total biomass yield in each cycle and site.
- Mean air temperature and daily rainfall for all areas
- Soil bulk density and soil water retention (long-term experiment)

Thesis in Brazil (General view)

The main objectives of the thesis are:

1) Long-term evaluation of sugarcane performance under different N inputs
2) Carbon and Nitrogen soil stocks after 4 sugarcane ratoons (4 years), and energy balance under contrasting N rates
3) 15N labelled fertilizer application under different conditions of N fertilization in long-term
4) Diazothrophic bacteria contribution on nitrogen nutrition of sugarcane (naturally and via inoculation).

Thesis in Brazil (General view)



N balance (inputs-outputs)

SOW at ORNL

- **Scope of work at ORNL**
  - **Nutrient requirements comparison between bioenergy crops**
  - **Global bioenergy crop modelling – EPIC model**
  - **Sustainability assessment – Sustainability indicators (Pire and NSF)**
  - **Building the database to bring N into MEND model**

SOW at ORNL

- Comparison of nutrient requirements between bioenergy crops
- Questions:

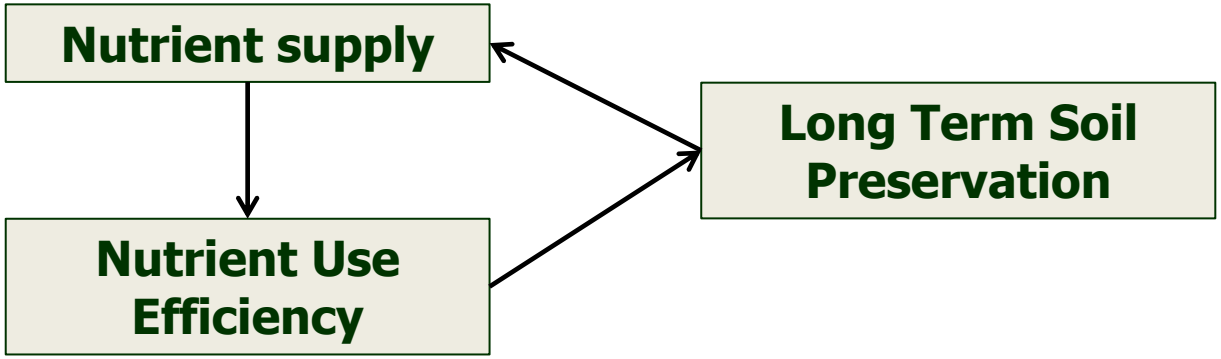
What is the amount of nutrients necessary to provide bioenergy production?

How will the consumption of nutrients affect global fertilizer stocks?

Is it possible to classify bioenergy crops depending on nutrients consumption and use efficiency?

SOW at ORNL

- **Issues of interest**



- **Nutrient requirement and Availability – Regional and World Scale**

Food vs Fuel

Cost of fertilizers as demand increases (large biofuel production scenario)

Is nutrient supply a constraint?

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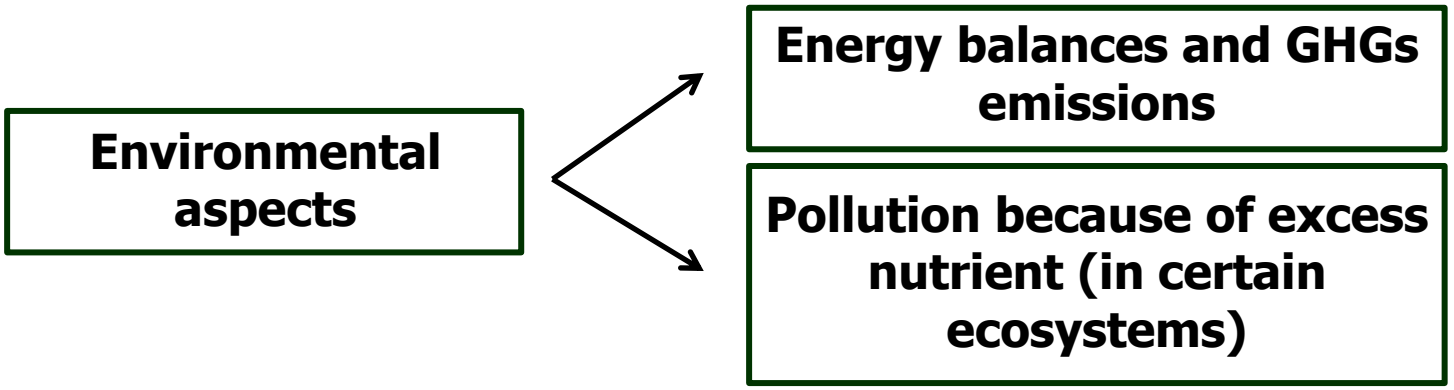
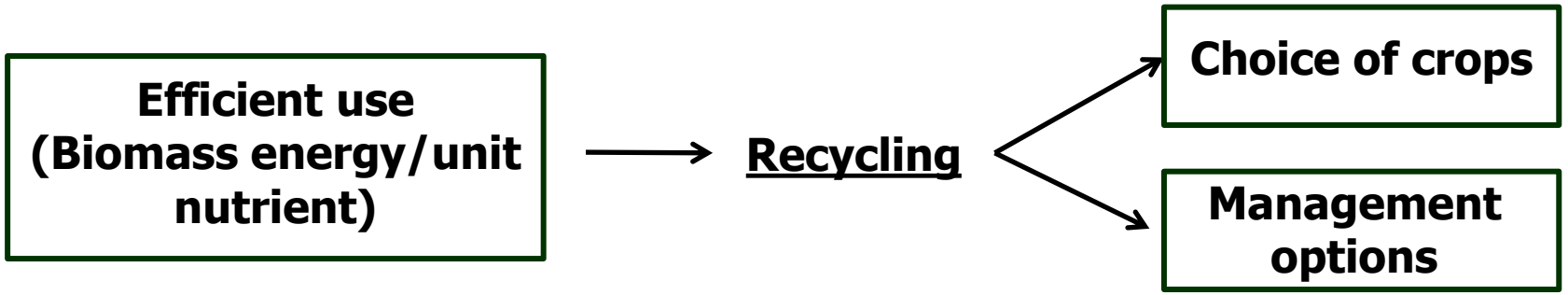
❑ **Sustainability requirements for biofuels are more rigorous than for food production**





Suitable Bioenergy Crop

- Successful crop: Cost-competitive and environmentally sound replacement for fossil fuel
  - High yields
  - Relatively low nutrient use (recycling is part of this)
  - Good environmental indicators

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How do different crops use nutrients to produce energy?

- Biomass/energy yield efficiency
- Ease of recycling nutrients
  - Topography may be an important constraint
    - Crops that can be cultivated in irregular landscapes

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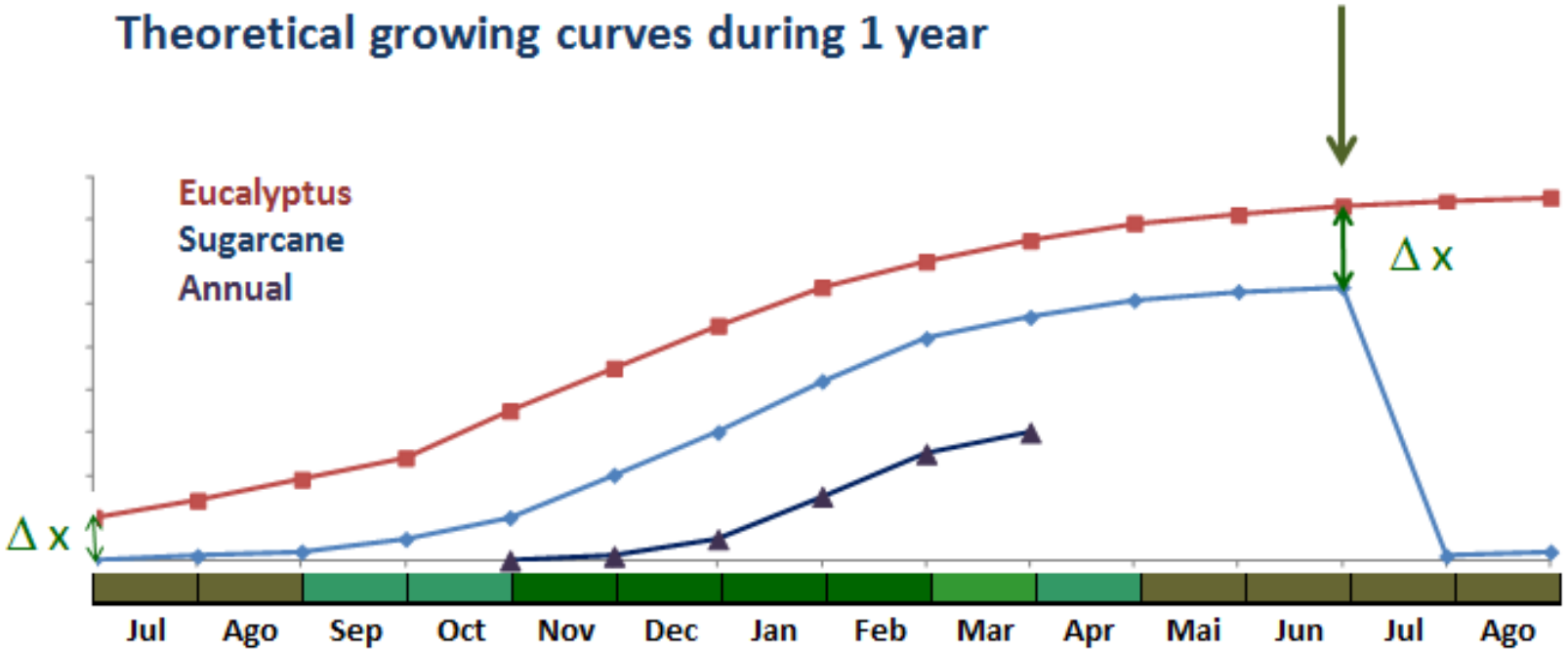
- Nutrient use efficiency of biofuel production: Crops
  - Annual crops (maize)
  - Temperate grasses (switchgrass)
  - Semi-perennial crop (sugarcane)
  - Tropical trees (eucalyptus)
  - Temperate trees (poplar)

SOW at ORNL

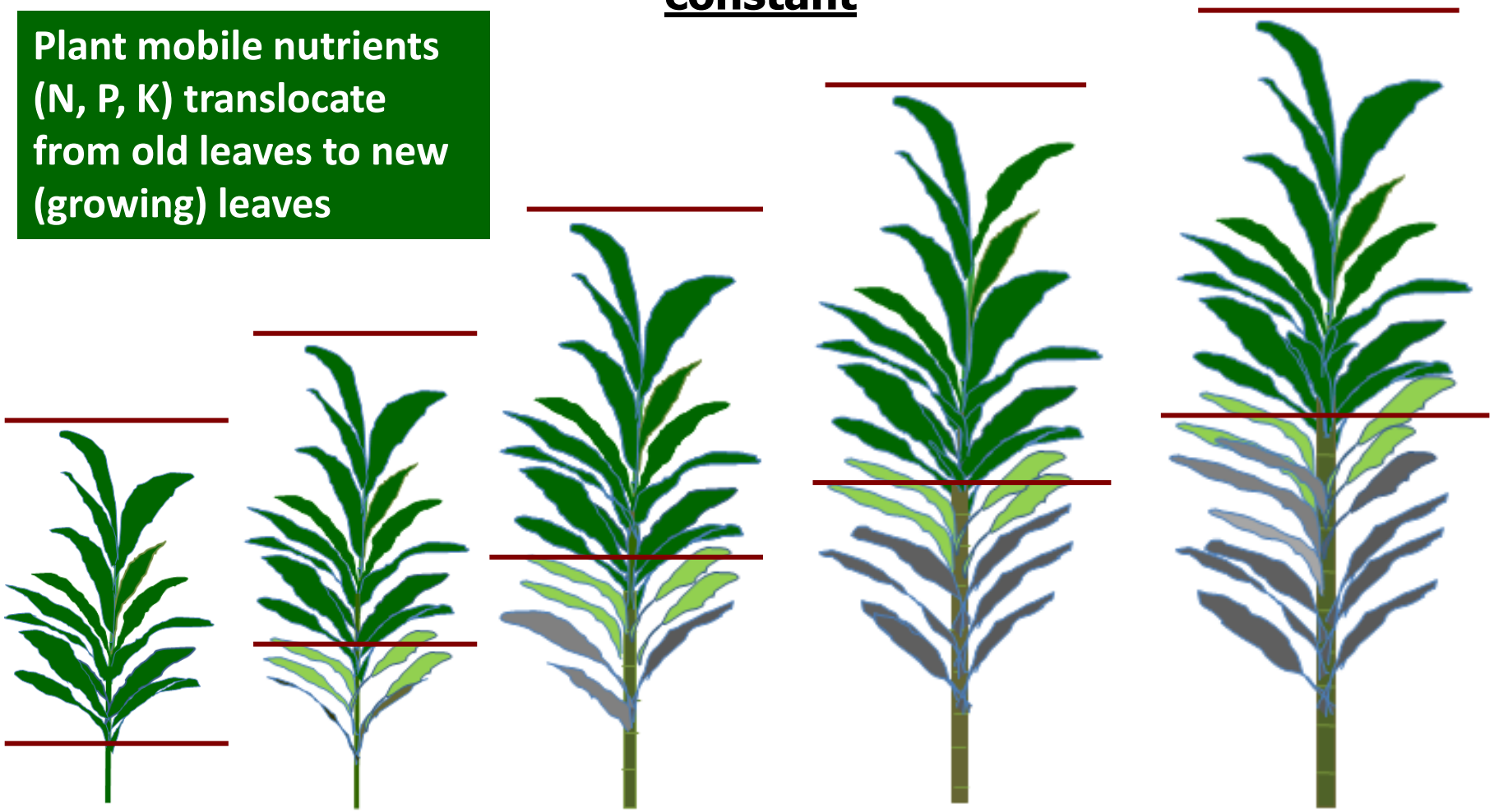
- **Biomass production: plants with different growing cycles**



Nutrient requirements are not proportional to biomass production

Photosynthetically active plant parts remain approximately constant

Plant mobile nutrients (N, P, K) translocate from old leaves to new (growing) leaves



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- Issues to be addressed
  - Investigate nutrient use efficiency (nutrient/biomass or nutrient/energy) of important biofuel feedstock
    - Compare important biofuel feedstock
    - Derive indicators for helping to choose more sustainable crops/management options
  - Investigate nutrient recycling opportunities of various feedstocks
  - Get the numbers right

SOW at ORNL

- **Global bioenergy crop modelling – EPIC model**
  - **Collaboration on refining the global crop model**
  - **Inputs of sugarcane data**
  - **Available data:**
    - **Climate, soil density, water retention, chemical attributes, sugarcane productivity**

Global Switchgrass Biomass Production Potential

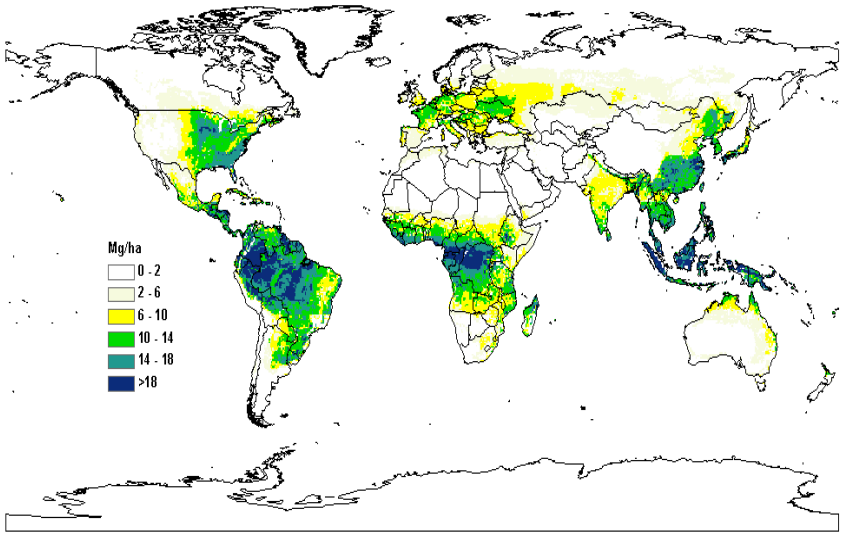


Fig. 1. Projected switchgrass productivity (Mg/ha)

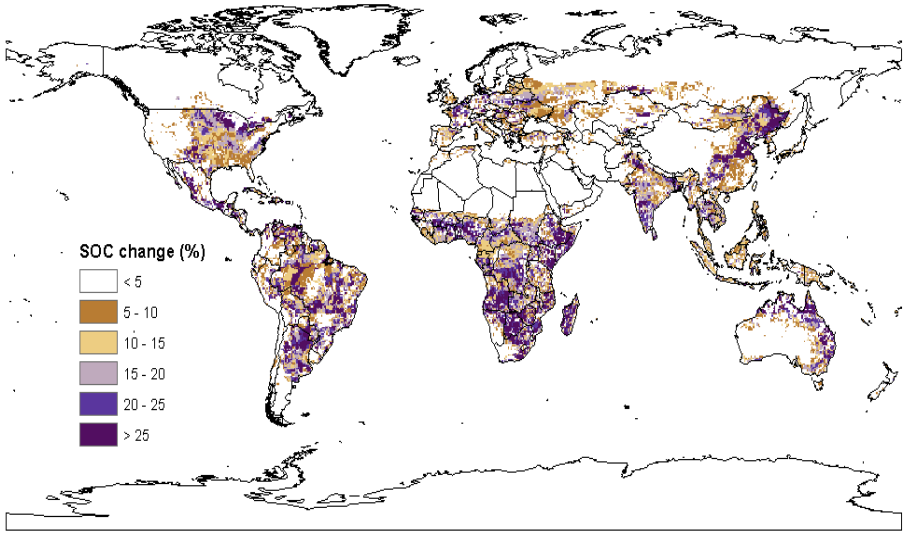


Fig. 2. Estimated soil organic carbon change (%) assuming 30 years of switchgrass cultivation

SOW at ORNL

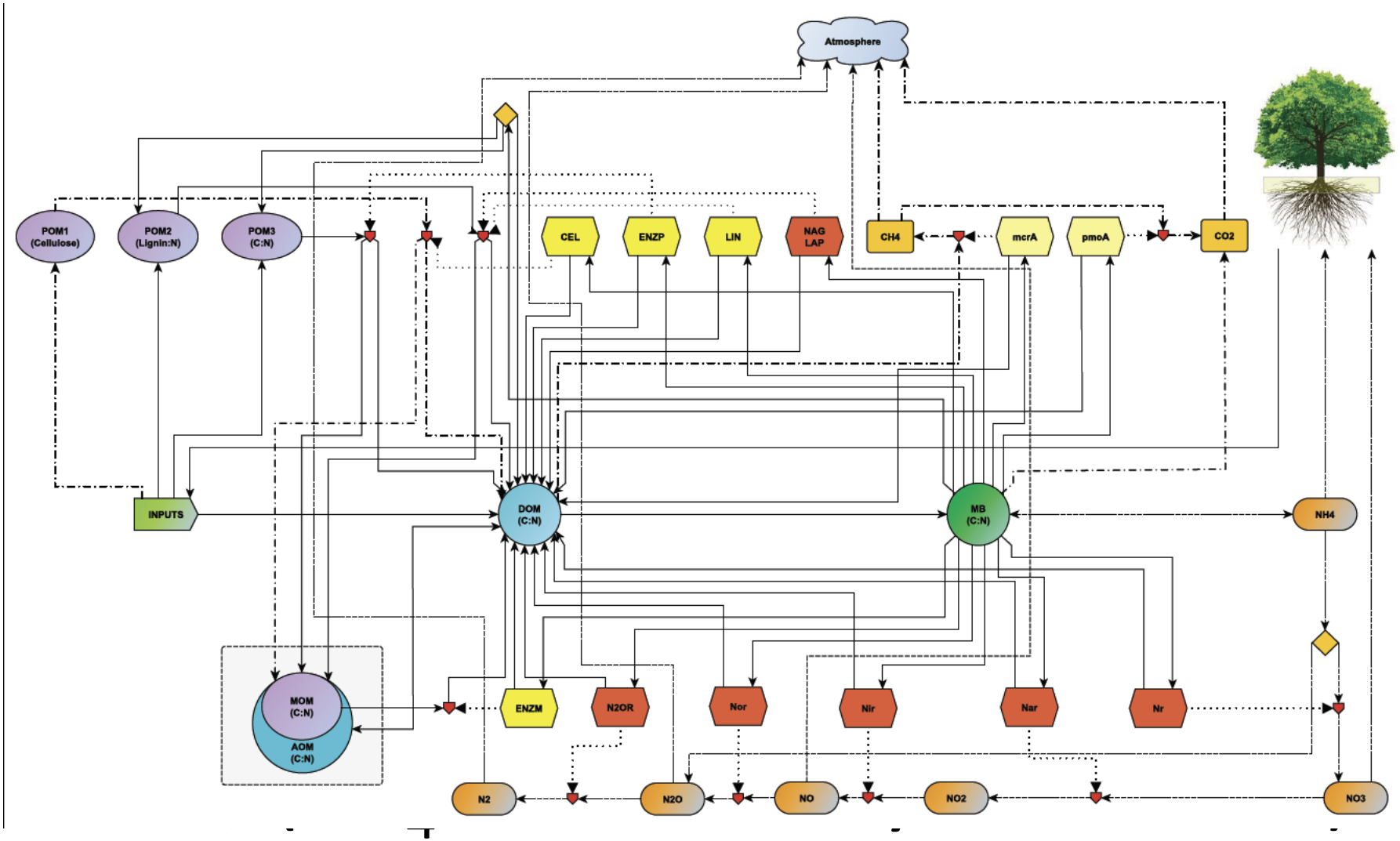
- **Sustainability assessment – Sustainability indicators**
- **Build skills for assessing sustainability as promoted under the Partnerships for International Research and Education (PIRE, an NSF funded project)**

SOW at ORNL

- Microbial-enzyme-mediated decomposition model (MEND)– Building the database to bring N into the model
- Determine, through literature review, appropriate parameters for major microbial exo-enzymes for N.

C-N, (CH_4 module may be refined)

(Wang, Mayes, Post)



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Thank You!