Biogeochemical Consequences of Agricultural Intensification in the Amazon Basin

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Introduction

The intensification of agriculture is a globally important component of land use change that has major biological and biogeochemical effects. In recent years, the most rapid expansion of the area devoted to agriculture and the largest increases in the intensity of agricultural practices and fertilizer use have occurred in the tropics on sites that were once forested.

In the Amazon Basin, forest clearing from the 1970s to the 1990s converted large areas of tropical forest to agricultural areas. The legacy of more than two decades of high forest clearing rates is an enormous area of pasture land that is now one to three decades old, situated in the developed corridors along the Basin's major road networks.

This aging pasture is poised to play a dominant role in the biogeochemistry of the Amazon Basin in the future. In the near term, intensification is likely to focus on making extant pastures more productive through a variety of treatments including disking, and replanting of pasture grass, perhaps following the planting and harvesting of a cash crop such as rice or soybeans. In the longer term, some of the pastures may be permanently converted to row-crop farms that will concentrate on producing lucrative export crops.

Objective

The objective of this research is to determine the biogeochemical consequences of agricultural intensification in the Amazon Basin.

Till (Block 1)

Approaches

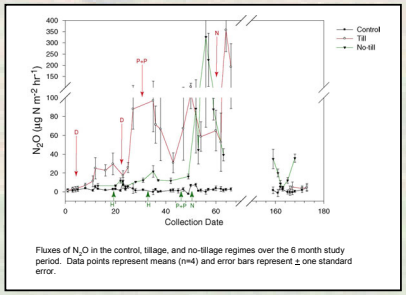
We are pursuing three related approaches in this research:

- Intensive experimental studies at Fazenda Nova Vida in central Rondônia
- Extensive observational studies throughout Rondônia
- Modeling studies to scale the results of the field studies to the region

Design of Intensive Field Studies

- Control plots plus 4 sets of treatment plots
- 4 replicate blocks
- Plot size 40m x 40m
- Treatments
  1. Soil tilling followed by replanting of grass and fertilization
  2. No-till application of non-selective herbicide, planting of rice, harvest followed by no-till replanting of grass and fertilization
  3. The same no-till sequence with soybeans instead of rice
  4. Application of a selective herbicide and fertilization with grass replanting

Preliminary Results



Fluxes of N_2O in the control, tillage, and no-tillage regimes over the 6 month study period. Data points represent means (n=4) and error bars represent ± one standard error.

Table 1. Estimated emissions of three trace gases (CO_2, N_2O and NO) from the control, tillage regime and the no-tillage regime for the period October 2001 through March 2002 (6 months).

Treatment	CO_2 Emissions (Mt C ha^{-1})	N_2O Emissions (kg N ha^{-1})	NO Emissions (kg N ha^{-1})
Control	4.47	0.06	0.14
Tillage	5.89	1.46	1.42
No-Tillage	3.55	0.95	1.07

Research Questions

Question 1. How will agricultural intensification affect the physical characteristics of the soil system?

Question 2. How will pH, cation exchange capacity and soil stocks of carbon, nitrogen, phosphorus and the major cations (K, Na, Ca, Mg) respond to agricultural intensification?

Question 3. To what degree will plant nutrient availability be altered by agricultural intensification?

Question 4. What effects will the intensification of pasture management have on forage quantity and quality?

Question 5. How will agricultural intensification affect leaching losses of essential nutrients?

Question 6. To what extent will agricultural intensification change the emission rates of CO_2, N_2O and NO?

Question 7. How much will agricultural intensification increase the Basin-wide emissions of the greenhouse gases CO_2 and N_2O?

Students on the Project from USP

Ph.D.

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