Fluxes of Nitrous Oxide and Methane in Commercial Soybean, Rice, and Maize Crops on the Santarem-Belterra Plateau, Para State.

Fluxos de Oxido Nitroso e Metano em plantações comerciais de soja, milho e arroz no platô de Belterra, Estado do Pará.

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ABSTRACT
The west region of Para State, principally the municipality of the Belterra and Santarém, has tried since 2000 an expressive increase in their grain crops areas, specifically soybean, rice and, in 2007, corn. In 2005 the farmers planted 110,000ha of these crops. This brought a no avoid fertilizers applications, where nitrogen has contributed in the formulas to planting and cover application. After 2003, were installed throughfall and precipitation collectors (bulk deposition) to monitoring nutrients cycles in these planted areas on the forest and superficial water (rivers and streams), besides collect gas samples with static chambers in agricultural areas. Using liquid and gas chromatography were analyzed nitrate and ammonium, and nitrous oxide. The results shown that precipitation and throughfall waters have high nitrogen content, in which ammonium is prevalent in the precipitation and nitrate in throughfall, with richest factor of the 3.9 to nitrate and -0.2 to ammonium. Also, the fluxes values to nitrogen (monthly average) according to 3.4 kg $N.ha^{-1}$ in throughfall, and 3.1 kg $N.ha^{-1}$ in precipitation. The fluxes of the nitrous oxide were (average) 2.59 ng $N.cm^{-2}.hour^{-1}$ (conventional soybean), while in no till system this fluxes were 3.2 ng $N.cm^{-2}.hour^{-1}$. In the superficial waters were observed light undulation during seedbed period (rainy season), with average value of the 0.24 ppm, in the six rivers and streams studied. The principal conclusion is that nitrogen fertilizers used in the crops are going to the forest and the forest is using this nitrogen to supply its necessity to grown.

INTRODUTION
The western portion of the state of Para has been the scene of accelerated development of commercial mechanized agriculture with rice and soybean as the main cultivars. After 2004, maize was an important crop, too. Planted area exploded from only 500 ha in 2000 to 110,000 ha in 2005. Thereafter, in 2006 a fall in the price of grains led to a reduction of planted area to only 50,000 ha in 2006. In light of this explosive change in land use, we initiated studies of the soil-atmosphere exchange of the greenhouse gases nitrous oxide and methane in the Santarém and Belterra municipalities.

METHODOLOGY
We used established static chamber methods to measure fluxes with gas chromatographic analysis of gas samples. In 2005 and 2006 we sampled rice and soybean crops in a conventional tillage system, where farmers applied between 12 and 30 kg N ha-1 for rice and between 0 and 8 kg N ha-1 for soybean (Table 1). In 2007 we also sampled maize (30 kg N ha-1 fertilizer) and soybean (7.4 kg N ha-1) in low till system fertilizer application. All N fertilizer was applied in the form of urea. We sampled daily during the first week after fertilizer applications and once per week thereafter. We made 10 chamber assays for each cropping system. The samples were analyzed using gas chromatography systems (Shimadzu GC-8A and GC-14A, with ECD and FID detection for nitrous oxide and methane, respectively).

RESULTS

Fluxes of the nitrous oxide varied widely depending upon the crop and the managements system employed (Table 1). The greatest crop season emissions (44.8 kg-N ha-1) were observed for the 2005 rice crop under conventional tillage with the addition of 28.5 kg-N ha-1 over the 107 day season (Figure 1). The smallest emission (4.5 kg N ha-1) for any crop season was for soybean under conventional tillage in 2007 (Figure 3). Soybeans under low tillage during the same year emitted 6.5 kg N ha-1 with the same fertilization of ~8 kg N ha-1. Methane fluxes showed little difference among crops although variation under upland rice was considerable ranging from consumption of -8 mg CH4 m-2 d-1 to emission of 9 mg CH4 m-1 d-1 (in 2005) (Figure 1).

CONSIDERATIONS / CONCLUSIONS

- Corn in low till showed 46% more nitrous oxide emission than soybean;
- Rice show different trend to nitrous oxide emission than soybean;
- Peaks during harvest period increase too much the emission of the nitrous oxide;
- Low till system increase nitrous oxide emission in soybean in 24%;
- No fertilizer in soybean can induce more N emission.
- Corn use 8x more N fertilizer to produce 2x more than soybean.

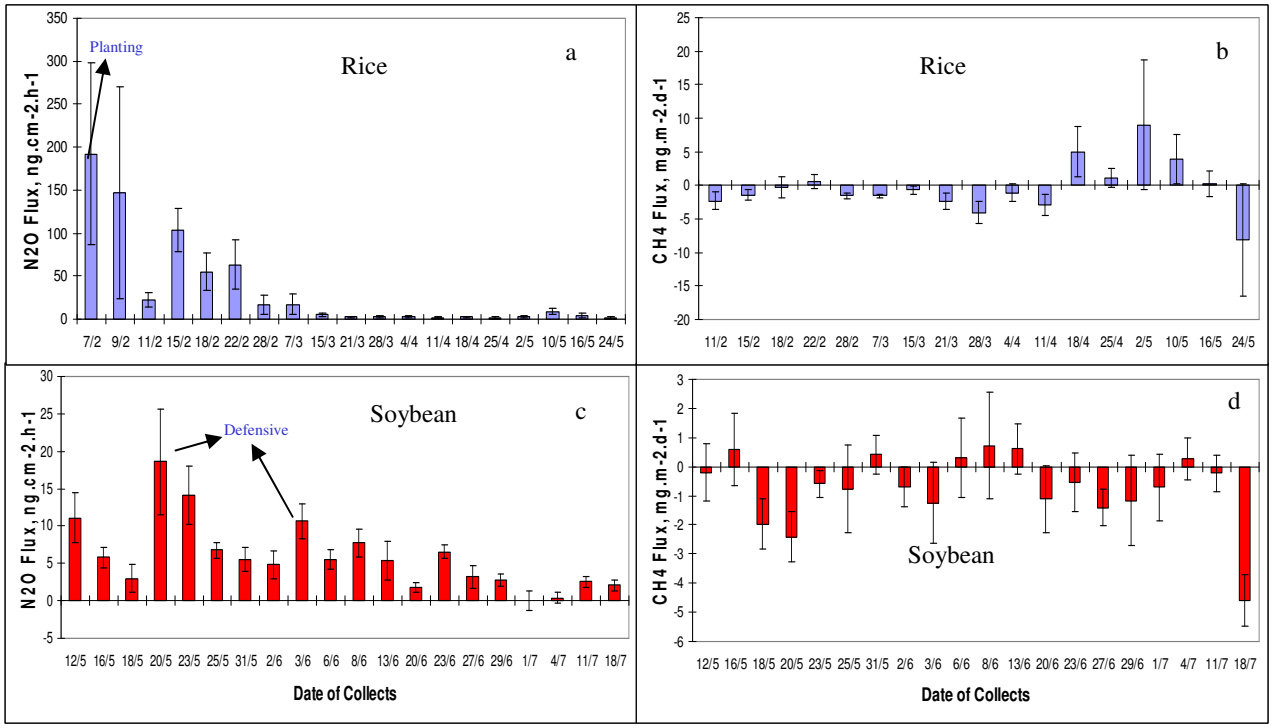

Figure 1. Nitrous oxide and methane fluxes in rice (blue) and soybean (red) during the 2005 crop season. Note the different scales and the large difference in the early season fluxes between rice (a) and soybeans (b) for nitrous oxide. Also note the higher variability in methane fluxes for rice (c) as compared to soybeans (d). Error bars are standard errors of the mean for each sampling date.

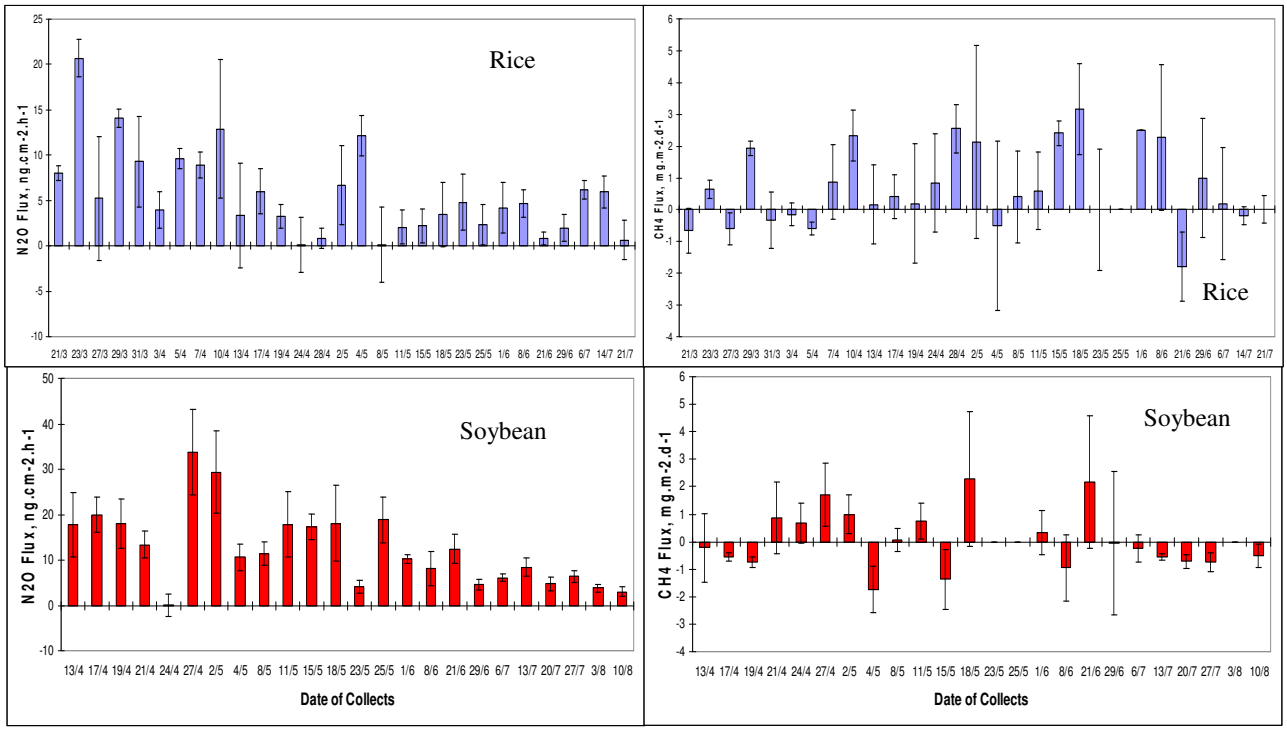

Figure 2. Nitrous oxide and methane fluxes in rice (blue) and soybean (red), respectively, in 2006. Error bars are standard errors of the mean for each sampling date.

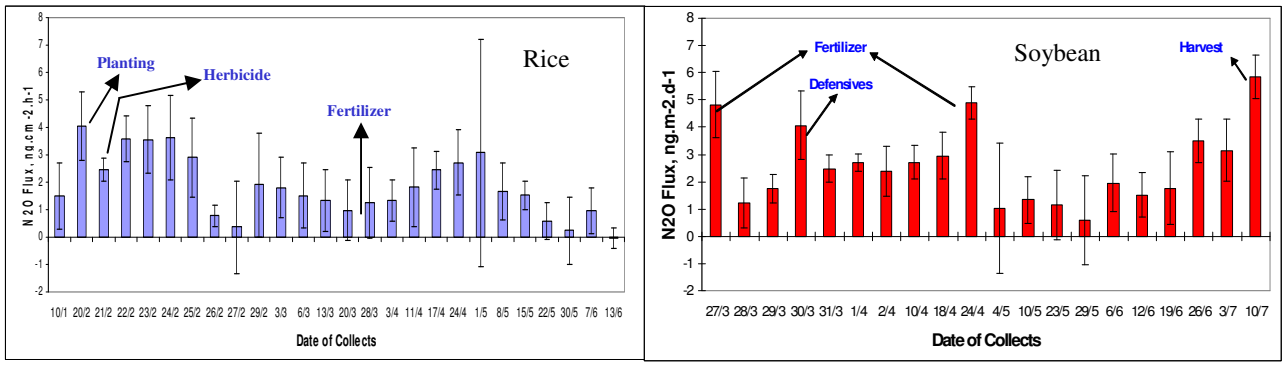

Figure 3. Nitrous oxide fluxes in rice (blue) and soybean (red) for conventional tillage systems during the 2007 season. During 2007 we had problems with the FID detector and therefore there are no methane data. Note the large fluxes in soybeans at the times of fertilization, pesticide application, and harvest. Error bars are standard errors of the mean for each sampling date.

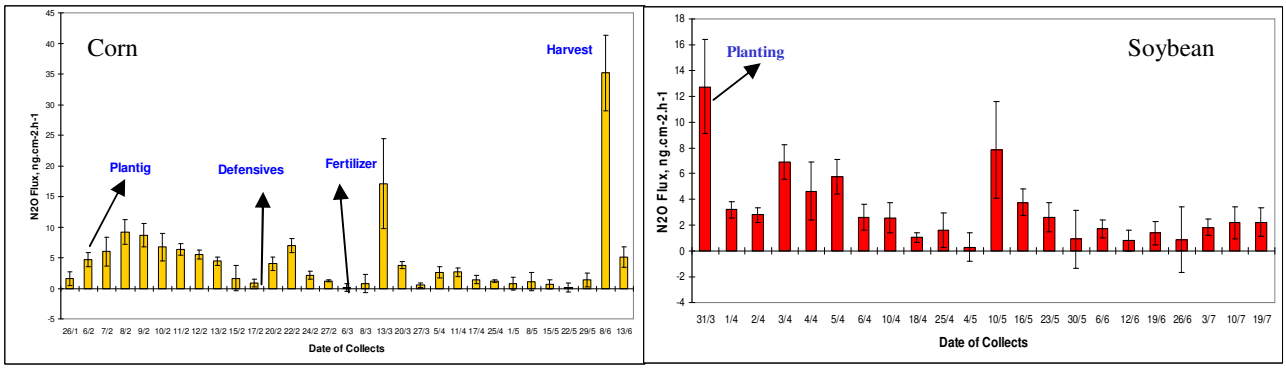

Figure 4. Nitrous oxide fluxes in corn (blue) and soybean (red) in low till systems during the 2007 season. Corn showed high emissions of nitrous oxide during the harvest period. Error bars are standard errors of the mean for each sampling date.

Crops	Years	Period	days	Time Average - kg N.ha^{-1}		Fertilizer kg N.ha^{-1}
				period	days	
Rice	2005	02/07 - 05/24	107	6.78	0.06	28.50
	2006	03/21 - 21/07	124	1.92	0.02	12.00
	2007	02/20 - 06/13	116	0.45	0.004	30.00
Soybean	2005	05/12 - 07/18	68	1.08	0.02	8.00
	2006	04/13 - 08/10	109	3.36	0.03	no fertilizer
	2007	03/27 - 07/10	106	0.68	0.01	8.00
Corn *	2007	01/26 - 06/13	114	1.27	0.01	60.40
Soybean *	2007	03/31 - 07/19	109	0.68	0.01	7.40

* = Low till system

Table 1. Compilation of integrated seasonal fluxes and average daily fluxes of N2O as well as total seasonal fertilizer additions for all crops and tillage systems studied.