COMPARATIVE STUDIES BETWEEN A PASTURE AND A RUBBER-TREE PLANTATION IN PARANÁ – ENERGY BALANCE, RADIATION AND CO_2 FLUX

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Introduction

Although the rubber-tree is native to the Amazon region, new clones have made the species more adaptable to areas outside the 8°N to 8°S region, which are very favourable due to the absence of ideal conditions for major pests and disease outbreaks. Field experiments in agroforestry conducted by the IAPAR over the last 15 years have indicated that rubber-tree plantations are well suited for recovery of degraded soils, and provide employment for several workers and income after the sixth year (PEREIRA, pers. comm.).

While much attention has been given to quantification of carbon sequestration by established and new forest (WOOD et al., 1992, JOHNSTON et al., 1996), less research has been conducted in tropical agroforestry systems. These agroforestry systems present social advantages by maintaining rural jobs and providing continuous income for farmers and have been the focus of on-going research in Brazil (BAGGIO et al., 1997, CARAMORI et al., 1996), but environmental aspects related to carbon sequestration have not been studied.

In association to the Inter-American Institute for Global Change Research, a research project is being developed with the main objective of quantifying the potential of rubber-tree plantation for carbon sequestration.

As an introductory study, this article has the objective of presenting preliminary comparisons between measurements done over a rubber-tree plantation and those over a pasture, during a campaign occurred in February, 2003.

Material and methods

This study was performed at Fazenda Guanabara, in Paranapoema, located 100 km north of Londrina, Paraná (lat: 21° 41' S, long: 52° 06' W), from February 6 to 19, 2003.

The rubber-tree plantation has an area of 250 ha, 15-year old, and the canopy averages 15 m. A 18 m tall tower was fixed in this area, where the micrometeorological sensors were installed. During the first measurement period, from February 6 to 13, the following sensors were installed at 17 m: a sonic anemometer (CSAT3), a CO_2/H_2O analyzer (LI7500), a net radiometer (NR Lite) and a PAR sensor (LI190). At the 11 and 6 m levels, two other PAR sensors were installed (LI190). Beside this area, in an extensive pasture (0.4 m high), a metallic post was fixed, and at about 4 m high a sonic anemometer (CSAT3), a Krypton hygrometer (KH2O), a net radiometer (NR Lite) and a PAR sensor (LI190) were installed. During the second period of measurements – from February 13 to 19 – the CO_2/H_2O analyzer was transferred to the pasture site, and the Krypton hygrometer to the rubber-tree site. Throughout the experiment, close to the base of the towers, a soil heat flux sensor (HFT3) and a soil temperature sensor (108-L) were installed, about 2 cm deep.

Sonic anemometer data as well as CO_2 and water vapor concentrations were collected and stored at a 20 Hz frequency, using a datalogger (CR23X) and a handheld computer (PSION5mx). Other measurements were done at 10 Hz, but only the 30' statistics were stored.

Sensible, latent heat and CO_2 fluxes were calculated using the eddy-covariance method, which uses the covariance between the fluctuations of the vertical wind and the variable in study, as the equation:

$$F_s = \overline{w's'}$$

where *w'* is the vertical wind fluctuation, *s'* is the fluctuation of the variable in study – temperature, water vapor concentration or CO_2 concentration, in this study. The gas analyzer used is an open path infrared CO_2/H_2O analyzer deigned for use in eddy-covariance flux measurement systems.

Hourly data of temperature, relative humidity, rainfall, solar radiation, wind velocity and direction were collected by an automated meteorological station located in the pasture site.

Results and discussion

Wind speed. As presented in Figure 1, the wind speed measured using the sonic anemometer over the pasture was larger than measured above the rubber-tree canopy. The difference in the surface roughness is probably the most important factor.

Soil measurements. On average, the soil temperature at the pasture site was 2.4° C higher than at the rubber-tree site, due to shading at the forested area. The soil heat flux presented higher

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diurnal values at the rubber-tree site. More negative values of heat fluxes measured on Feb 10 and 17 were due to rainfall, and were more intense in the pasture site. (Figure 2)

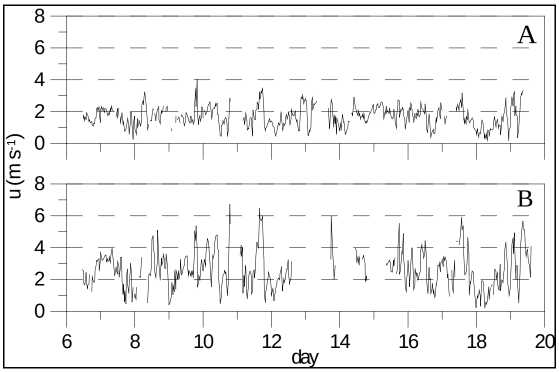

Figure 1. Wind velocity comparison: measurements above the rubber-tree canopy (A) and above the pasture (B). Paranapoema, Feb 2003.

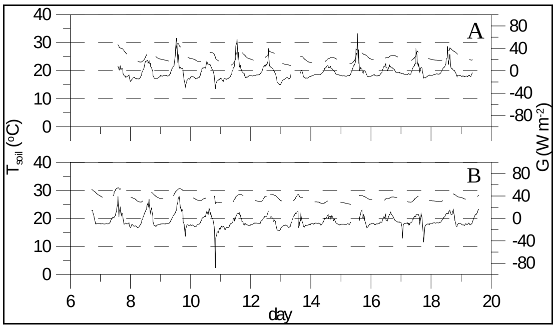

Figure 2. Soil temperature (traced lines) and heat flux (continuous line) comparison: measurements at the rubber-tree site (A) and at the pasture site (B). Paranapoema, Feb 2003.

Photossynthetically active radiation. The PAR sensors installed inside the rubber-tree canopy showed the differences in radiation penetration as presented in Figure 3.

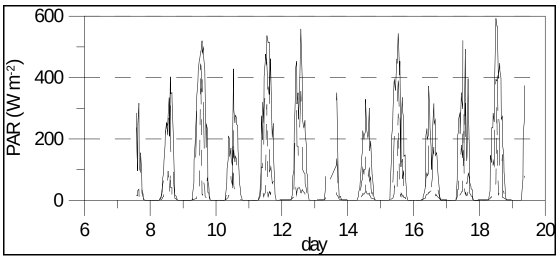

Figure 3. PAR measurements above and inside the rubber-tree canopy – at 17 m (continuous line), at 11 m (traced line), and at 6 m (dotted line). Paranapoema, Feb 2003.

Carbon dioxide flux. Fluxes measured above both sites are presented in Figure 4. The period of measurements above each area is not long enough to observe trends, but the data collected does not show significant differences between the sites studied. The higher values showed in the graph, as on Feb 13 or Feb 17 are not to be considered as real flux value, but must related to sensor limitations during rainy periods.

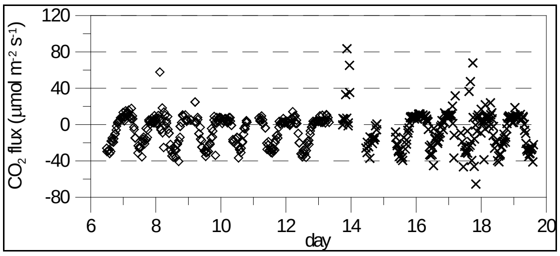

Figure 4. Carbon dioxide flux: measurements above the rubber-tree canopy (◊) and above the pasture (×). Paranapoema, Feb 2003.

The next step of the project is to perform a second campaign of data collection, during the winter. The quantification of the potential of rubber-tree plantation for carbon sequestration and its comparison to pastures can be used to facilitate the development of a network in monitoring carbon sequestration in agroforestry systems. It will also help police makers to deal with the Clean Development Mechanism proposed by the Kyoto Protocol.

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