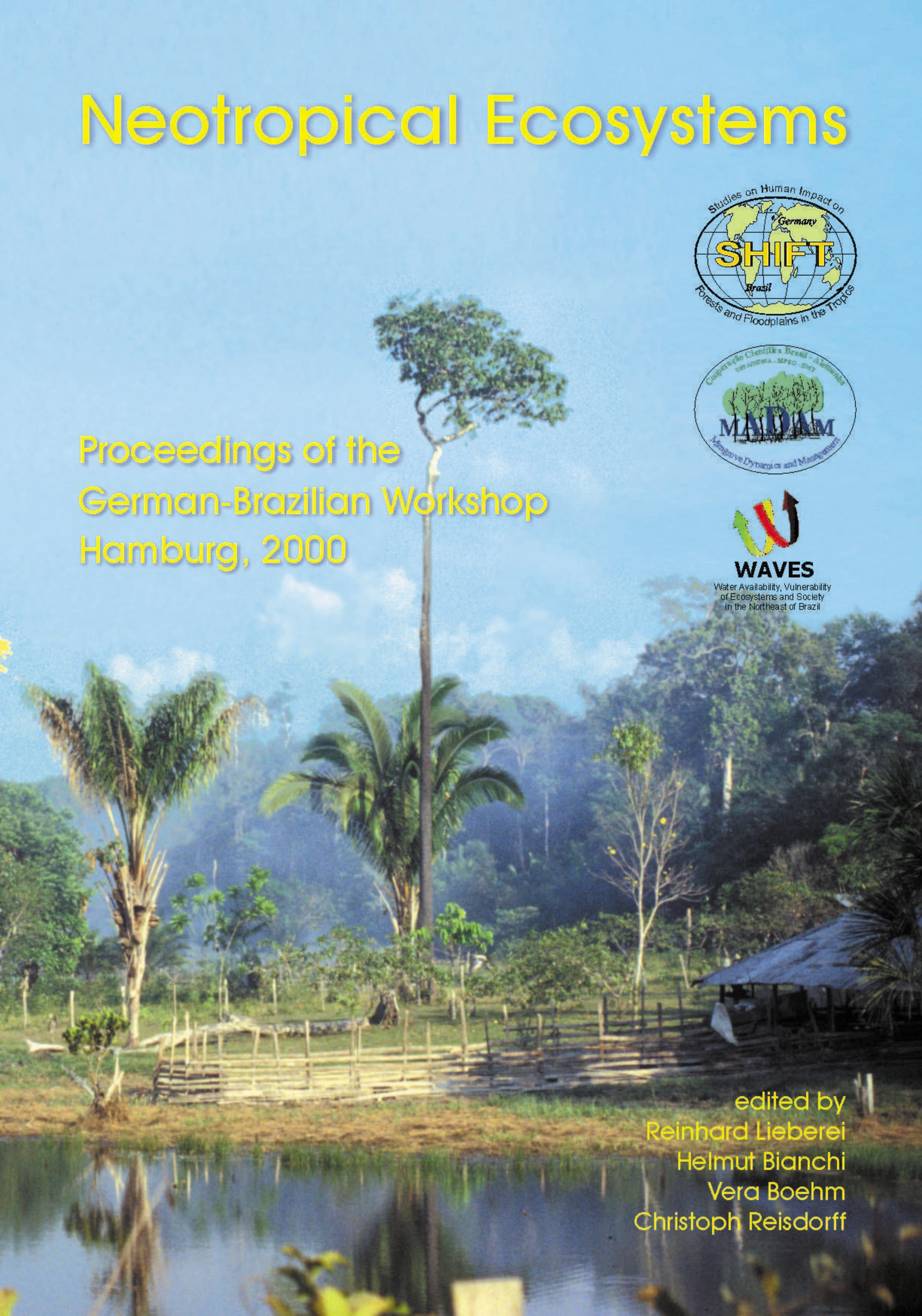
# Neotropical Ecosystems





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edited by
Reinhard Lieberei
Helmut Bianchi
Vera Boehm
Christoph Reisdorff

**Editors** Reinhard Lieberei [1], Helmut K. Bianchi [2], Vera Boehm [1], Christoph Reisdorff [1]

[1] Universität Hamburg, Institut für Angewandte Botanik, Ohnhorststr. 18, 22609 Hamburg, Germany

[2] GKSS-Forschungszentrum Geesthacht GmbH, Max-Planck-Straße 1, 21502 Geesthacht Germany

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# Primary Productivity in Fallow Vegetation in Northeast of Amazon – an Alternative Method for Biomass Determination

**Cattanio, J. H. [1,2], Sá, T. D. de A. [2] and Vielhauer, K. [3]**

[1] Embrapa Amazônia Oriental, Belém-PA, Brazil,

[2] CNPq Scholarship, Brazil,

[3] ZEF, University of Bonn, Bonn, Germany

**Abstract**

Accompaniment of the primary productivity increment, as well as aerial and underground biomass, in altered ecosystems, is an important mechanism to assist in the understanding of the nutrients and water cycle, such as carbon accumulation. We proposed an efficient mechanism for accompaniment of primary productivity through Leaf Area Index (LAI) and Root Increment Index (RII) in different height of "capoeira" (fallow vegetation). The LAI was monthly evaluated not destructively, through of the canopy analyzer apparatus, LAI-2000-Li-Cor and the RII was estimate in the same plots for LAI study with ingrowths bags. The estimate of LAI by not destructive method with a canopy analyzer and the use of effortless RII methods seem to be a viable option for primary production studies in secondary vegetations. The results in the analysis of the monthly variation of LAI reflect specific features of each vegetation, associates to the history of earth use, where the time in fallow at the moment of the evaluation (related as age of the "capoeira") is not the only factor to differentiate the vegetations. The high RII in 400 cm of depth, in all studded "capoeira", suggest mechanisms for water and nutrients access in soil's deep layers, for "capoeira's" species.

**Keywords**

Primary productivity, LAI, IIR, Secondary vegetation, Amazon.

## 1 Introduction

The "capoeira" (fallow vegetation) is a common example of modified area in the Amazon, however it is an efficient structure to recover the potential of agricultural productivity (Brown and Lugo 1992). In this direction, the accompaniment of the primary productivity increment, as well as aerial and underground, in these perturbed ecosystems, become a important mechanism to assist in the understanding of the nutrients and water cycle, such as carbon accumulation.

Direct methods of biomass determination, aerial as underground, are generally expensive and difficult execution; due to are temporarily and spatially variable. The determination of the leaf area index (LAI) for indirect method, done through measurement of the radiation that passes through the canopy, is an important tool in the accompaniment of the primary ecosystem productivity. This method is faster in comparison with the direct method, and has a good indicative of comparative parameters on the canopy processes in agricultural and forest structures (Welles, 1990; Welles and Norman 1991).

In natural vegetation a substantial primary production happens below the soil, in the root system, varying with the soil type and vegetation. The roots are the largest sources of organic matter in the soil system, and of it the plants depend in the search of minerals and water, for support and storage reserves. Due to this measurement the root system became an important mechanisms to understand the biochemical processes inside of a determined ecosystem. However, this type of measurement have a particular difficulty, because the root extraction of the soil requests high consumption of time, intense field work and laboratory active, in addition it is done by methods that alter the soil structure.

Also, another important point to consider comes from the vegetative cycle in this fallow system. Analyses of root system from 1 year of "capoeira" can have a great error when didn't separate live roots from died root. This error comes from the fact that the roots of the secondary vegetation, previous to the felling of trees for the crop system (before the fallow), can be being measured 3 years later, when the agricultural phase was conclude and the fallow has 1 year old. Therefore, when we do not separate live roots from dead roots we are sampling material proceeding from two ages of "capoeira" or distinct forms of vegetation.

The objective of this work is to accompany during the two seasonal periods of the year in a false time sequence of "capoeira": i) the LAI obtained by an equipment with an optical sensor (LAI-2000 Plant Canopy Analyzer, LiCor), ii) the index of root increment (RII) was obtained with "ingrowths-bags". The hypothesis is that LAI and RII are positively correlated and they increase proportionate with the "capoeira" age. Also, we can wait a larger root increment in the soil surface, however at the drought season is possible to exist a considerable root increment in depth, due to need of water absorption, principally in younger "capoeira". Starting from this dates will give an important step in the sense of understanding the carbon cycle and help in measurement of the biogeochemistry cycles in theses important areas of fallow system in the north-east of Pará state.

## 2 Material and Methods

This work was carried on producer's areas in Igarapé-Açú, Pará (0° 55'- 1°20' S, 47°50'- 47°50' W), where the SHIFT-"capoeira" project (ENV-25) comes accomplishing researches there are approximately six years. Due to the type of earth's use, familiar agriculture, inserting annual cropping and fallow periods, this area presents one mosaic of "capoeira" with different ages and annual cropping. The region present level relief with soils of type Ultisols (Kandiudults-USDA-soil taxonomy; REGO et al. 1993). In general the soils of the region are sandy soils (80-90% sand) in the top 10 cm and have increasing clay content of around 30% at between 50 and 100 cm depth. The precipitation regime is approximately 2000-3000 mm per year, with a defined drought station, that is going from July to December, which average rain in this period is 346 mm (DINIZ, 1986).

The leaf area index (LAI) was monthly evaluated not destructively, through of the canopy analyzer apparatus, LAI-2000-Li-Cor. The measurements were carried in three plots of 50x50 m, for "capoeira" of 6 and 10 years old (average height 3.5 and 6.5m, respectively), and in three plots of 30x30 m for "capoeira" of 1 year old (average height 1.5m). The "capoeira" age is a personal communication from farmers. Whole the plots were outline with strip of 1 m, maintaining the vegetation at the level of the soil, to liven up the outside interference of the plots. Points predetermined for monthly measurements of LAI, were demarcate with pickets around of the plots. The measurements were made with a sight reducer of the optical sensor, with opening of 30° for "capoeira" of 10 year old and of 90° for another "capoeira", and stored in a data logger. The restriction of the angle of sight was made to decrease the influence of the existent variation in the spatial structure of the canopy (WELLES and NORMAN, 1991). After the measurement in the field the data were retired for a computer, and made calculations for the accompaniment of LAI total for each point.

RII was found with demarcation of two points in opposite sides for each plot. These points, in the "capoeira" of 6 and 10 years old, were located 15 m of the beginning of the transept and 4 m of border rows to inside of the plot, and each point was separate each older for 20 m of distance. In "capoeira" of 1 year old the first point was located 10 m of the beginning of the transept and 3 m of the borderline, and the distance among the points was of 10 m. In each point they was dug with increment borer, whit internal diameter of 16 cm, and three holes until 4 m of depth was made. The holes were arranged in triangle figure and distant approximately 1.5 m one of another. Therefore, for each point of monthly sampling of LAI, 3 points exist for half-yearly measurements of RII.

Bags of root increment (ingrowths-bags), previously prepared with nylon screen with mesh of 2 mm and area of 80 $cm^2$ (10 cm x 8 cm), was filled with dry earth of underground (standardized for all the bags), previously sifted in mesh of 2 mm and all organic matter was discarded. All bags were closed whit hot machine and the last opening was sewed with nylon line (0.2 mm) after place the soil. In each bag a nylon line (2.0 mm) was tied with the approached length of the size of the depth where the bag would be, and the accessible extremity in the surface of the soil. After the bags were placed, the hole was filled with the removing earth from the own hole, until the depth of the next bag, and successively until closing the hole. Them used depth was 400, 300, 200, 100, 50, 30 cm and surface (0-10 cm). The bags were placed in the beginning of the dry and rain station (summer and winter), and in the two periods the same holes were used. The total bags for each depth, "copoeira's" age, and season were 36.

The removed of the bags were made in an inverse way of the described above. Firstly it was retired the earth of each hole to the height of the bag of root increment. After this, with aid of the 2.0 mm nylon line, the bags were pulled upward, placed in labeled plastic bags and taken for laboratory. The root, which was out of the bags, was discarded. All the bags were droughts firstly (105° for 24 h), and the whole material and mesh nylon, separately was weighed. After weighed, the soil whit the root material was washed in current water, with sieve of mesh < 2.0 mm of diameter. All root material from inside of the bag was manually collected, and dried to 65 °C until constant weight, and the samples were weighted. For calculate of RII for each bag the following equation was used: RII = Weight of roots/Density of the soil inside of the bag.

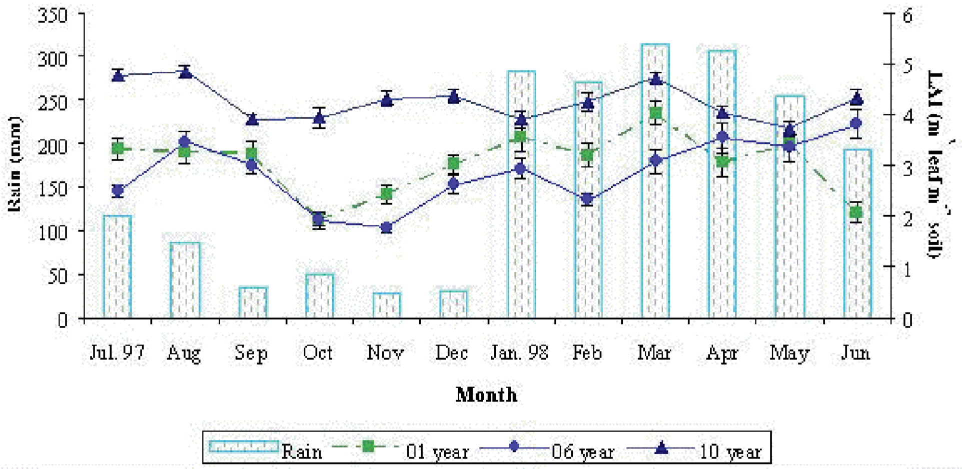
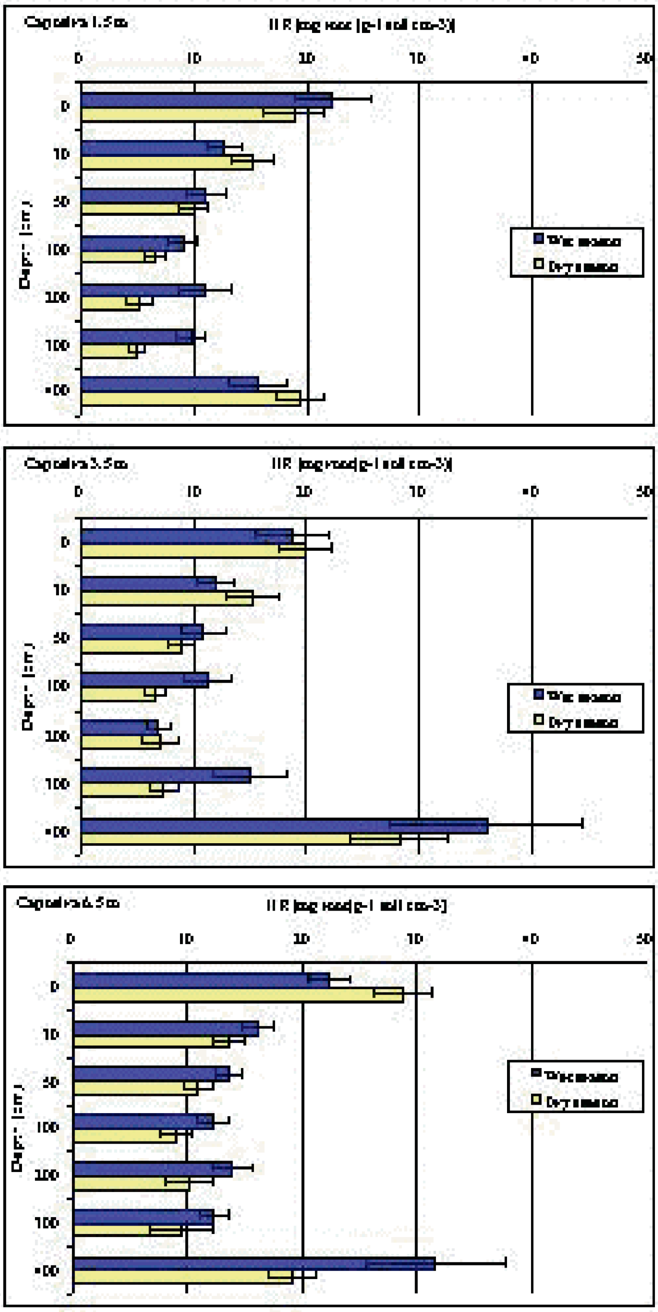



Fig. 1: Monthly leaf area index (LAI) for "capoeira" of 1, 6, and 10 years old in Igarapé-Açú. (Average and S.E.)



## 3 Results

The data of LAI during one year of measurement (Fig. 1) showed that "capoeira" of 10 years had a greater LAI during all year. However, our hypothesis did not confirm for "capoeira" of 6 and 1 year old, because the "capoeira" of 1 year old had presented some times bigger LAI of than 6 years old. Also, the data showed that the "capoeira" of 1 and 6 years tend to increase LAI (1.40 and 1.53 $m^2/m^2$, respectively) in according with the increase of rains. However, the "capoeira" of 10 years had not exactly presented a severe increase in the same period (0.95 $m^2/m^2$).
The results from RII showed didn't exist a clear variation in the root growth between wet and dry season, in the three age of "capoeira" (Fig. 2). However, the data showed, for all the studied age, existed an intense root growth in depth, mainly in the 4 m, where depth had presented greater root development in the dry season (Fig. 2).
The total fine root increased in 4 m of depth on one year was 3.56, 4.29, and 4.40 mg $cm^{-3}$ for "capoeira" of 1 (1.5 m of weight), 6 (3.5 m of weight) and 10 (6.5 m of weight) years old, respectively (Tab. 1), which didn't show statistic variation in the same age for dry and wet season. Root increment in one year in 4 m of depth contributed with 20, 32 and 20% of total root biomass increment for 1 (1.5 m of weight), 6 (3.5 m of weight) and 10 (6.5 m of weight) years old, respectively. However, the majority of root increment was found in the first 1 m of depth (Tab. 1), which was 55, 43, and 53% for the same respectively sequence of "capoeira" above specified.

Fig. 2: Root increment index (RII) in dry and wet season in "capoeira" of different weight in Igarapé-Açú. (Average and S.E.)

| Depth (cm) | "Capoeira" 01 year old (mg root cm⁻¹ soil) | | "Capoeira" 06 year old (mg root cm⁻¹ soil) | | "Capoeira" 10 year old (mg root cm⁻¹ soil | |
|---|---|---|---|---|---|---|
| | Wet season | Dry season | Wet season | Dry season | Wet season | Dry season |
| 0 | 0.398(0.052) | 0.456(0.065) | 0.321(0.050) | 0.514(0.061) | 0.438(0.046) | 0.709(0.063) |
| 30 | 0.262(0.032) | 0.376(0.052) | 0.227(0.031) | 0.391(0.059) | 0.306(0.024) | 0.346(0.034) |
| 50 | 0.222(0.034) | 0.237(0.035) | 0.189(0.036) | 0.221(0.029) | 0.276(0.024) | 0.269(0.029) |
| 100 | 0.165(0.023) | 0.165(0.027) | 0.176(0.027) | 0.163(0.021) | 0.231(0.029) | 0.178(0.019) |
| 200 | 0.174(0.041) | 0.114(0.024) | 0.109(0.016) | 0.152(0.030) | 0.230(0.026) | 0.210(0.039) |
| 300 | 0.165(0.021) | 0.113(0.018) | 0.294(0.072) | 0.164(0.024) | 0.215(0.024) | 0.133(0.015) |
| 400 | 0.277(0.045) | 0.438(0.054) | 0.702(0.238) | 0.665(0.104) | 0.461(0.089) | 0.398(0.038) |
| Total | 1.66 | 1.90 | 2.02 | 2.27 | 2.16 | 2.24 |

Tab. 1: Root content (mg $cm^{-3}$) in ingrowths bags on soil depth (cm) for "capoeira" of 1, 6, and 10 year old during the wet and dry season in Cumaru, Pará. [Average(standard error)]

The estimate of LAI by not destructive method with a canopy analyzer and the use of effortless RII methods seems to be a viable option for comparative primary production studies in secondary vegetations. The results in the analysis of the monthly variation of LAI in the three age of studied "capoeira", reflect specific features of fallow vegetation, associates to the history of earth use, where the time in pousio at the moment of the evaluation (related as age of the "capoeira") is not the only factor to differentiate the vegetations. The RII appears to be a good method for study of deep root system, principally in these fallow systems, which have a cycle of fallow intercalate with crop time. The height RII in 400 cm of depth, in all studded "capoeira", suggest mechanisms for water and nutrients access in soil's deep layers, for "capoeira's" species.

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