Changing the slash-and-burn agriculture in Brazilian Eastern Amazonia by enriching the fallow vegetation

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ABSTRACT

Most of the agriculture in the Brazilian Eastern Amazon is based on slash-and-burn, with cropping for one to two years and followed by fallow periods of 3-8 years. The fallow vegetation maintains the system's productivity through biomass and nutrient accumulation. Nowadays the fallow periods are short and there is not enough time for the soil to recover its fertility for the next cultivation cycle, resulting in a decrease of the agricultural productivity. To overcome this problem and in order to improve biomass accumulation, the vegetation's vitality and to shorten the fallow period fast growing trees were planted associated with the annual crops maize and cassava. The leguminous tree species *Acacia angustissima, Clitoria racemosa, Inga edulis* and *Acacia mangium* were planted at densities of 2,500; 5,000 and 10,000 plants per hectare. The tree biomass production was accelerated after cassava harvest. Cassava yield was not influenced negatively by the tree growth, neither the trees were affected by the crop. According to the *A. mangium* performance after 1.5 years, it is predicted that after 2.5 years the above-ground biomass will be approximately equivalent to 4-5-year-old fallow vegetation.

RESUMO

A maioria da agricultura na Amazônia brasileira Oriental baseia-se na prática de derruba e queima, com cultivos entre um a dois anos, seguido de pousio de 3 a 8 anos. A vegetação de pousio mantém a produtividade do sistema devido ao acúmulo de biomassa e nutrientes. Atualmente, os pousios são cada vez mais curtos, não havendo tempo para que o solo recupere sua fertilidade natural, resultando na diminuição da produtividade agrícola. Para resolver este problema, visando aumentar o acúmulo de biomassa, manter a vitalidade da vegetação secundária e encurtar o tempo de pousio foram introduzidas árvores leguminosas num ciclo agrícola de milho e mandioca. As espécies *Acacia angustissima, Clitoria racemosa, Inga edulis* e *Acacia mangium* foram plantadas nas densidades de 2.500, 5.000 e 10.000 plantas por hectare. O acúmulo de biomassa das árvores foi acelerado depois da colheita da mandioca. Não houve influência negativa das árvores na produção de mandioca e nem as árvores foram afetadas pela mandioca. Baseado na performance de *A. mangium* após 1,5 anos, prevê-se que com 2,5 anos o acúmulo de biomassa aérea será aproximadamente equivalente ao de uma vegetação secundária de 4-5 anos.

ZUSAMMENFASSUNG

Der Großteil der Landwirtschaft im brasilianischen Osten Amazoniens basiert auf der Brandrodung mit einer ein bis zwei Jahre dauernden Anbauphase, gefolgt von 3-8 Jahren Brache. Die Brachevegetation erhält die Produktivität des Systems durch die Akkumulation von Biomasse und Nährstoffen. Bei den heutzutage immer kürzer werdenden Brachephasen wird die Bodenproduktivität nicht mehr regeneriert, was in einer Abnahme der landwirtschaftlichen Produktivität resultiert. Zur Bewältigung dieser Problematik wurden zwecks Erhöhung der Biomasse-Akkkumulation, der Erhaltung der Vitalität der Sekundärvegetation und der Verkürzung der Brachedauer Baumleguminosen in das Anbausystem mit Mais und Maniok integriert. Die Pflanzdichten der Spezies *Acacia angustissima, Clitoria racemosa, Inga edulis* und *Acacia mangium* betrugen 2500, 5000 und 10000 Pflanzen pro Hektar. Erste Ergebnisse zeigen, daß sich die Biomasse-Produktion der Bäume nach der Maniokernte beschleunigte. Es wurde weder der Maniokertrag negativ vom Wachstum der Bäume beeinflußt, noch die Bäume durch den Maniok. Basierend auf der Entwicklung von *A. mangium* nach anderthalb Jahren, kann vorhergesagt werden, daß nach 2,5 Jahren die oberirdische Biomasse der ange-reicherten Brache der einer ca. 4-5 Jahre alten natürlichen Brachevegetation entsprechen wird.

INTRODUCTION

Most of the agriculture in the Brazilian Eastern Amazon involves slash-and-burn with cropping for one to two years, followed by fallow periods among three to eight years. During the fallow period a spontaneous secondary vegetation grows up maintaining the system's productivity through biomass and nutrient accumulation. In places of high demographic pressure the fallow periods are short and there is not enough time to the soil recovers its fertility for the next cultivation cycle, resulting in a decrease of the agricultural productivity. To overcome this problem and in order to shorten the fallow period by improving the vegetation's vitality and its biomass accumulation it was evaluated the performance of fast growing leguminous tree planted associated with the annual crops maize and cassava.

ENRICHED FALLOW EXPERIMENT

On an on-farm experiment in Igarapé-Açu (Northeast of State of Pará) the leguminous tree species *Acacia angustissima*, *Clitoria racemosa*, *Inga edulis*, and *Acacia mangium* were planted at 2,500 5,000 and 10,000 plants per hectare in randomized blocks with four replications. The experimental area was slashed and burned in November of 1994. In January and February of 1995 corn and cassava were planted, respectively. The trees were introduced in June of 1995 after corn harvest. Thus, trees and cassava lived together for eight months until the cassava harvest in February of 1996. Since then, trees and fallow vegetation grew together, resulting in an enriched fallow.

RESULTS

Planting the trees into the standing of cassava crop resulted in a rapid development of the trees after cassava harvest and accelerated biomass production. Cassava yield was not influenced negatively by the tree growth, neither the trees were affected by the crop. Survival rates of planted tree were more than 90% for all species. The shading by the cassava plant assured good establishment and controlled tree growth to a permittable extent as long as the crop were still in the field. At 18 months of age planted tree species had the same growth pattern, independent of spacing (Fig. 1).

The secondary vegetation biodiversity is a function of its age and previous land management. Denich (1989) found 183 species of 54 families among trees or bushes and lianas in secondary vegetation of 4-5-year-old. In secondary vegetation of 20 year-old Salomão et al. (1996) observed 26% of primary forest specie (316 species ha^{-1}). In enriched secondary vegetation (12 months of age) the spontaneous vegetation varied in function of planted tree spacing. Increasing trees spacing, increased the number of fallow vegetation species. In all fallow vegetation experimental study area were found 274 species belonging to 73 plant families (Wetzel, 1997).

As secondary vegetation is getting older there is an increase of above-ground biomass accumulation. Nunez (1995), in Eastern Brazilian Amazon, found values of 22, 45 and 68 ton ha^{-1} in secondary vegetation of one, four and seven year old, respectively. The total above-ground biomass accumulated in enriched fallow vegetation was a function of planted tree spacing (Fig. 2). Increasing spacing decreased tree biomass and increased the secondary vegetation biomass. Although 10,000 plants per hectare showed the largest planted trees above-ground biomass accumulation, it can not be considered inadvisable due to suppression of fallow vegetation. Thus, spacing between 5,000 to 2,500 plant per hectare would be more favorable, due the possibility to synchronize growth among planted trees and the fallow vegetation. Faster growth species could be preferably planted in wider spacing (2,500 plant per hectare), while slow growth species in small spacing (5,000 plant per hectare). For *Acacia mangium* based on its performance up to 1.5 years old, it is possible to estimate that after 2.5 years the above-ground biomass will be approximately equivalent to 4-5-years-old secondary vegetation.

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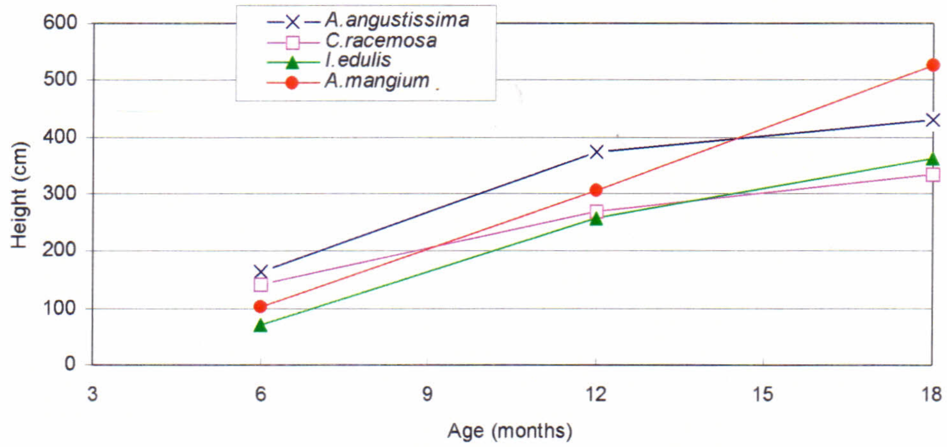

Figure 1: Height as a function of age of *A. angustissima, C. racemosa, I. edulis* and *A. mangium* planted for enrichment of fallow vegetation

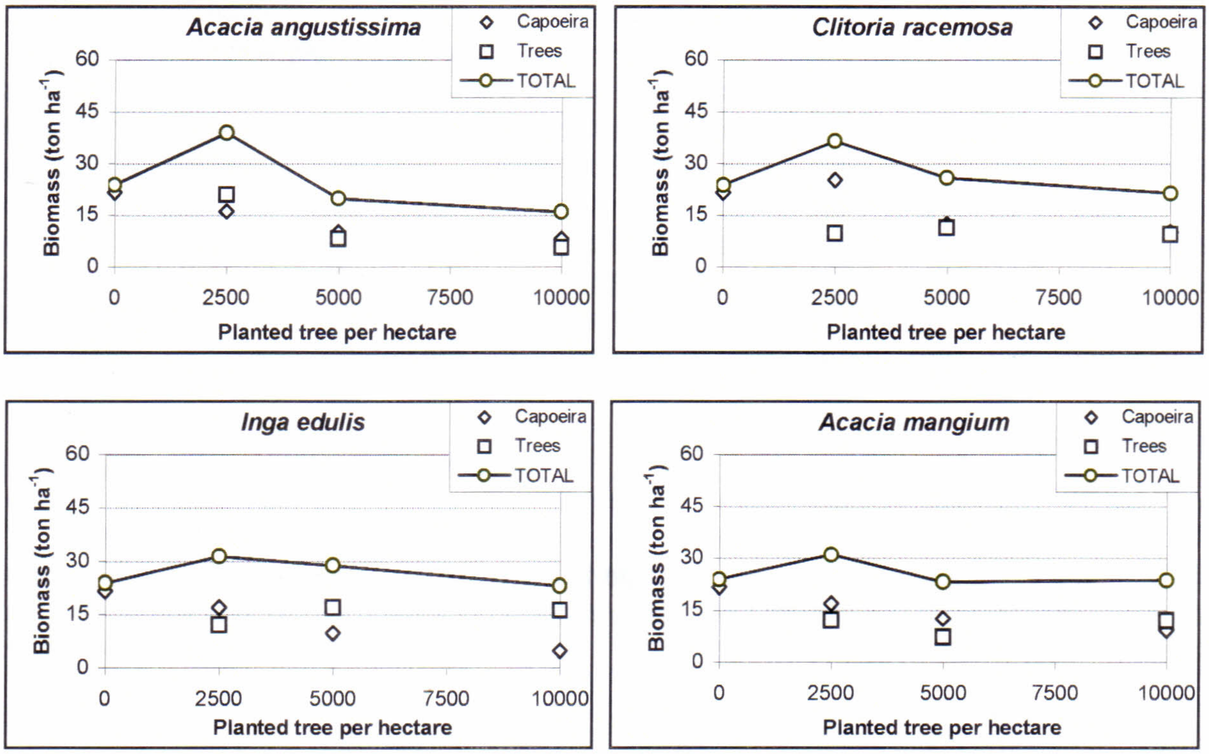

Figure 2: Above-ground biomass of fallow vegetation and the tree specie *A. angustissima, C. racemosa, I. edulis* and *A. mangium* planted at 2,500 5,000 and 10,000 plants/ ha