A SILVOPASTORAL SYSTEM IN THE NORTH ATLANTIC ZONE OF COSTA RICA: COMBINING INDIGENOUS TIMBER SPECIES WITH DAIRY PASTURE SWARDS

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ABSTRACT
The objective of this study was to design, establish and monitor a silvo pastoral experiment on a dairy farm in the northern Atlantic region of Costa Rica. Indigenous timber species, *Vochysia guatemalensis* and *Hyeronima alchorneoides* were used together with or without the tropical pasture legume, *Arachis pintoi* in a split plot design with a 4 x 2 x 2 factorial arrangement. First year establishment was good for the tree component (2.3 to 10 % mortality) but poor for *A. pintoi* (4 to 5 % of sward). Poor legume establishment was attributed to lax grazing management and excess competition from existing *Brachiaria sp. A. Pintoi* was reestablished in July 1996 after an adjustment of stocking rate. This experimental project is planned for a 10 year period which corresponds to the expected rotation length for harvesting the indigenous timber species.

KEYWORDS
Tropical pasture, dairy, timber, legume, establishment, agroforestry

INTRODUCTION
Promotion of alternative land uses such as agroforestry systems and the development of sustainable agricultural alternatives are key elements of the reclaimation of degraded pastures converted from forest, Quesada, (1990) and Montagnini, (1992). In Costa Rica, environmental awareness has stimulated the strengthening of environmental policies. As a result, ranchers are intensifying their cattle systems and implementing new strategies to increase productivity per hectare, Lutz, (1993). This intensification could decrease or even reverse the net conversion of forest to pasture. Agroforestry systems have a high potential in assisting with soil conservation efforts and maintaining soil productivity levels (Young, 1989). Silvo pastoral systems represent a subdivision of agroforestry that deals with pasture, animal, and tree interactions Jonsson, (1995). If one of the major driving forces behind deforestation is pasture land expansion, then the adoption of sustainable silvo pastoral systems may reduce the need for land clearing by maintaining or increasing productivity. A major limitation to the development and implementation of silvopastoral systems is the scarcity of experimental data to confirm its potential. This is particularly true with regards to the "tree component". Researchers have focused most of their attention on trees that provide immediate tangible goods (i.e. herbage protein banks, fuel wood, nitrogen fixation, live fences, etc.). Other than the trees that spontaneously grow on pastures, timber species have not been purposefully integrated with pasture swards.

MATERIALS AND METHODS
The objective of this study was to design, establish a long-term, silvo pastoral experiment on a dairy farm in the northern Atlantic region of Costa Rica and to quantify important varibles influencing establishment. The farm is located in the San Carlos region of Costa Rica (10° 26' N, 86° 75' W, 700 meters mean elevation, 24°C mean annual temperature, 4000 mm annual rainfall, with maximum in July minimum in March, tropical rain forest life zone). The soils are classified as Typic Dystrandepts. The area was cleared in the 1930s and is presently being grazed. Two indigenous timber species, *Vochysia guatemalensis* and *Hyeronima alchorneoides*, that have a proven capacity of growing in pasture conditions under minimum supervision were selected. The dominant species in the pastures were grasses (*Brachiaria decumbens* and *Brachiaria ruziziensis*), brush (*Psidium guajaba, and Citrus sp*), and trees (*Gliricidia sepium, Xanthoxyllum mayanum, Ficus sp, and Cordia alliodora*). The silvopastoral experiment was initiated in June, 1995, by introducing the tropical forage legume (*Arachis pintoi* CIAT 17434) and the two indigenous timber species *(Vochysia guatemalensis, Hyeronima alchorneoides*) into the existing pasture sward following a split plot design in a 4 x 2 x 2 factorial arrangement. *A. pintoi* was planted in rows at approximately 1.5 m apart, including the areas under the trees. Trees were planted in a double rows adjacent to paddock fenceline borders in staggered 4 x 2 m pattern. Initial planting density was approximately 200 trees/ha. The trees were excluded from the grazed swards by employing a temporary electric fencing system which used the existing paddock boundry fence on one side. Whole plots consisted of two paddocks, one with and one without *A. Pintoi*. Both paddocks comprising the whole plot contained the two tree species. Sub plots were defined by the two tree species. Each sub plot was stratified in three distinct 5 x 100 m sections containing two subunits of 5 x 50 m adjacent to the tree species. Section 1 included the area under the double row of trees, section 2 the interface between the trees and the pasture, and section 3 the pasture area farthest from the trees. Tree variables measured were: tree height (m), root collar diameter (cm), herbivory status (0=healthy , 1=slightly attacked, 2=attacked, 3=severely attacked, 4=dead) and qualitative herbivory status (an abbreviation is given for each kind of damage observed) and pasture varibles were: botanical composition, according to the procedures described by Mannethje and Haydock (1963) and mean herbage mass. Herbage mass was estimated using the falling plate disk meter as described by Green, et. al. (1989) and Mueller et. al. (1989). Data were analyzed using SAS-STAT with ANOVA in a split block design procedure (2 x 2 x 4).

RESULTS AND DISCUSSION
Forestry component. The average height for *Hyeronima alchorneoides* and *Vochysia guatemalensis* after six months of planting was 0.68 m and 1.06 m, respectively. The root collar diameter showed an inverse trend with *Hyeronima sp* significantly "thicker" than *Vochysia sp* (2.25 cm >1.89 cm). These different growth patterns may be attributable to the inherent characteristics of the species. *Vochysia sp* is an aggressive soft-wood species that invests its initial growth in developing sufficient height for successful establishment. In contrast, *Hyeronima sp*, a hardwood species, seems to invests its resources in the production of stem girth at the expense of height. At this early stage of the experiment it is only possible to comment on the degree of initial establishment success. Quantitative herbivory characterization of both *Vochysia sp* and *Hyeronima sp* exhibited low mortality percentages (3.09 % and 6.55%respectively). The primary cause of mortality was the damage caused by random attacks of leaf cutter ants (*Atta cephalotes*). Since the initial establishment of *Arachis* treatment was low, there was no significant main or interaction effects of the pasture treatment detected between the two trees species. In the future, it is anticipated that *Arachis*/tree effects may be present.

Pasture component. The data for each subunit were averaged, since there was no significant difference between the three sections [P< 0.05] within each subunit. One month after introducing *Arachis pintoi* in the existing pastures the botanical composition was determined for each experimental unit (Table 1) showing fair to poor establishment of the legume. *The Arachis* component ranged from to 2.35% to 8.85% of the available forage mass. Two different species of Brachiaria dominated the swards, *B. ruziziensis* and *B. brizanta*, with values ranging from 1.55% to 65.10%, and 14.44% to 83.35%, respectively. *B. Ruzii* was dominant in all paddocks. *B. brizanta* was introduced to the paddocks several years prior to the initiation of the experiment in an attempt to improve the sward composition. Weed infestation was a problem throughout the experiment ; this condition was inherited from previous management practices. Weeds comprised from 7.35% to 26.8% of the sward, well above the values for *Arachis pintoi*. It is expected that *Arachis pintoi* will eventually successfully compete with the weed population once it becomes established. Mean herbage productivity (Table 1) of the sward ranged from (2757.23-44534.42) Kg DM/ha. The production of high quality feed through introduction of *A. pintoi* and sound grazing management is an important goal of the project. The experiment is planned for a 10 year period which corresponds to the expected rotation length for harvesting the indigenous timber species .

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Table 1
The influence of pasture and tree species on the average (tree) height, root collar diameter, mortality, (pasture) herbage mass, and botanical composition 6 months after establishment, San Carlos, Costa Rica, January, 1996.

Treatment	Pasture						Tree		
	Herbage [1] Mass	Botanical Composition [2]					Heigh t	Root [3] Collar	Mortality
		B. Brizanta	*B. Ruzii*	*A.Pintoi*	weed	other grass			
	Kg/ha	----------%----------					m	cm	%
Vochysia + *Arachis*	3,667	17	54	4	15	10	1.01	2.21	2.3
Vochysia	3,343	13	58	-	14	15	1.03	2.28	3.8
Hyeronima + *Arachis*	3,291	13	58	5	9	15	0.71	1.96	4.1
Hyeronima	3,274	15	46	-	13	26	0.66	1.83	10.0

[1] Mean herbage mass
[2] *Brachiaria brizanta, Brachiaria ruziziensis, Arachis pintoi*
[3] Root collar diameter