Investigations on tree species suitable for the recultivation of degraded land areas in Central Amazonia

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Appendix 1

Wood characteristics of *Ceiba pentandra* cultivated in upland and floodplain ecosystem

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SUMMARY

The present work was carried out with tree sumauma's tree (*Ceiba pentandra*), native, adult and young trees cultivated in floodplains (varzeas) and uplands (terra firme) ecosystem, having as objective, obtain information about growth patterns of the species and to correlate them into different environmental conditions (floodplain and upland) as well as investigate anatomic and physical , parameters of the wood, purposing correlate the wood quality of adult native trees, with young tree's wood, cultivated in floodplain (varzea) and upland (terra firme).

It was studied the radial variations of density and anisotropy, as well as the wood anatomic structure on the pith-bark direction on the samples of wood got on the height at breast diameter (DBH).

It can be conclude, from the results obtained that: the cultivated trees at the floodplain and upland ecosystem, as well as, the natives, presented an increase of density on the pity-bark direction; the density was greater on the cultivated trees at the upland ecosystem, following the trees cultivated at the floodplain, when compared with native sumauma; the anisotropy contraction index gotten, indicate that sumauma is highly dimensionally unstable, presenting, limitation to uses such as construction; the average data of the density estimated,

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with the fitted regression equation by, ecosystem, one superior to the ones measured for native sumauma.

Key words: Sumauma, physical and anatomical characteristics, wood quality

Características da madeira de *Ceiba pentandra* plantada em ecossistemas de terra firme e várzea

RESUMO

O presente trabalho foi desenvolvido com árvores de sumaúma (*Ceiba pentandra*), nativa adulta e árvores jovens plantadas em ecossistemas várzea e terra firme, tendo como objetivo, obter informações sobre o padrão de crescimento da espécie e relacioná-la as diferentes condições ambientais (várzea e terra firme), bem como investigar parâmetros anatômicos e físicos da madeira objetivando correlacionar a qualidade da madeira de árvores nativas adultas com madeiras de árvores jovens plantadas na várzea e na terra firme.

Foram estudadas as variações radiais da densidade e anisotropia, bem como as estruturas anatômicas da madeira no sentido medula casca nas amostras de madeira obtidas na altura do DAP.

Pode-se concluir, a partir dos resultados obtidos que: as árvores plantadas nos ecossistemas de várzea e terra firme, assim como nativas, apresentaram um aumento de densidade no sentido médula-casca; a densidade foi maior nas árvores plantadas no ecossistema de terra-firme, seguido das árvores plantadas na várzea, quando comparado com a sumaúma nativa; os valores dos coeficientes de anisotropia de contração encontrados, demonstram que a sumaúma é altamente instável dimensionalmente, apresentando, portanto, limitações para uso em esquadrias; os dados médios da densidade estimados, com a equação de regressão ajustada por ecossistema, são superiores aos medidos para sumaúma nativa.

Palavras-chave: Sumaúma, características físicas e anatômicas da madeira, qualidade da madeira

INTRODUCTION

The species *Ceiba petandra* (L.) Gaertn, family Bombacaceae - sumauma of foodplain is a frondous tree, caducifolious leave, able to reach height superior to 60m, and diameter at breast height over 2,4m being the current height of 40 to 50cm, with diameter at breast height (DBH) of 130 to 180cm. The trunk is straight cylindrical and until 2/3 of the height without branches; the base of the trunk is clearly reforced, with buttresses well pronounced that can reach heights of 8,0m (Lamprecht 1990). When young, have branches and trunk provided of bulky conic aculeous, lonely or not (Loureiro and Silva, 1968). The wood is too light (0,30 to 0,37g/cm^3) and in current level is appropriated, especially to plywood. Their habitat is flooded tropical forest or swampy floodplain and also the elevated upland, with clayey and fertile soil.

The world pressure for the natural forest conservation is increasing and forcing the timber industries to change the source of suppliers. Some industries promise to plant millions of sumauma's seedlings in substitution to the native trees which exploration is taking them to extinction, to obtain wood with appropriate quality. The influences of the environment on the formation of the wood of these species at upland and floodplain are very important, because of the sumauma's natural distribution in both ecosystems of the Central Amazon. These environments present characteristics that make them morphologically different, although complementaries functionally.

Junk (1989) estimates that there is approximately 10.000 Km^2 of floodplain forest a long the large rivers. The shorter passages of these floodplain are occupied by flat border lakes, "floodplain lake". All the Amazon rivers are subjected to a period of overflowing during which the water overflow their river bed, and invade the border areas, overflowing with different degrees of intensity. Most of these rivers draw in their appreciable water amounts of sediments and during the overflowing, these mineral and organic detritus, are deposited on the inundated plain, giving them fertility and value to intensive production of food. The process is reproduced in all overflowing and the addition of fertility, resulting from the new colmalages allowing the agricultural exploration of these area, by following years, without the reduction of these productivity with the compromise of the result of the cultivation. The floodplain perform this way the role of a great biologic transformation, that receive nutrients from the Amazon river and change them in organic matter, which by it time will be used by plants and animals of the system.

In the dense vegetation which is developed on the "terra firme", the expression used to low ground of amazonic high plain which are out of the water rivers action and of the flood tide, their edaphic system is normally poor and low fertility, predominating soil which are originated in the early formation of the Amazonic Basin (Tertiary and Pleistocene) with more than 100.000 years, the most recent deposit. Beside this , prevails on this environment dystrophic latossols and unusually eutrofics (Schubart and Salati 1982; Veloso et al, 1991). The same way, Fernandes and Serrão (1992) and Falesi (1986) emphasizes the unlikely characteristics of the latossols (Oxissols) and the podzols (Ultissols) that occur in the upland saying that 75% are acid soils and of low fertility, is characterized by the poor supply of nutrients, high aluminum, toxicity and low availability phosphorous.

According to Shimoyama (1990) the quality of the wood refers to its adaptation to a specific use or of their ability to fill the requirement needed to the manufacture of specific product, knowing the quality of the raw material and the process to be used, is possible to obtain the optimization between both and the end product.

Therefore the quality of the timber is the result of the agreement of the physical, chemical and anatomic properties. On the determinations of the wood quality, the basic density is the most used index, because it affects the other properties of the wood and consequently their products.

All the species producers of wood own natural, changes in their characteristics which are providing from different answers to the conditions ,which the tree has been developed. These changes are intrinsic to the growth of the tree and must be taken to condition, when any study is done about the quality of the wood (Larson 1962, Brazier 1977). The change on the chemical , physical and anatomic composition of the wood are great between species, occurring changes also inside the same species, especially, in function of the age, genetic and environmental factors (Browning 1963). The increase of the growth rate, inside of some limits, cause the increase in the wood density. The tree's age also affects the timber density. Usually the density increase sharply during the young period after in a slow way, until get the adult phase keeping more or less constant henceforth. The modifications in the wood density due the fertilizations or from the irrigation are similar to those occasioned by changes in the growth rate.

The behavior's study of the dimensional change of the wood is essential to its industrialization, specially in the makings of plywood. The relation existing between density, humidity and retractibility of the wood, are of fundamental importance for the correct utilization. Species can be discarded in their utilization when the dimensional stability is an important factor. By the way the study of the characteristic of wood movement has allowed the utilization of species less stable, to obtain products of high quality, as plywood. It's possible to select wood more stable, with basis only in data obtained in laboratory (Galvão and Jankoswsky 1985).

On this context, this work had as aim to obtain information about the sumauma growth pattern and to correlate to different environmental conditions (floodplain and upland), as well as, to investigate anatomic and physical characteristics of the wood of young cultivated tree at the floodplains and at the upland and to make the correlations with to the quality wood of the native adult trees.

MATERIAL AND METHODOLOGY

In this work was used sumaumas' trees (*Ceiba petandra*) cultivated in a floodplains ecosystem in an experimental area of INPA, located at Costa do Caldeirão - Iranduba city; in an upland ecosystem at experimental area of EMBRAPA, located on Km30, AM-010 Highway and, native trees of floodplains collected by GETHAL - AMAZONAS S. A., Industry of plywood located at Itacoatiara city, Amazon state.

Characterization of the study area

FLOODPLAIN ECOSSYSTEM

The study was developed with sumauma cultivated tree at Iranduba city in the region named Costa do Caldeirão, Ariaú Station from INPA-CPCA, in the left side of the Solimões river, 50Km above of the meeting between Negro and Solimões river. The cultivation was carried out in October, 1992 and in January, 1993. Two trees were cut and carried out dendometric, measurement of overall height (Ht) and diameter at breast height (DBH) as Table1.

Table 1 - Dendometric characteristics of sumauma's tree cultivated at the floodplains and uplands ecosystem

Tree	Ecossystem	DBH (cm)	Ht (m)
01	Floodplain	21,1	8,45
02		21,3	6,92
01	Upland	26,8	14,8
02		32,3	17,3

The Iranduba city, in Amazon state, hold an overall area of 2354Km^2, corresponding approximately 0,15% of Amazon state area. The city is between the latitude 3°00' and 4°00' S and longitude 60°00" and 61°00" W Grw. It's located in the Medium Amazon been established in large part of recent Quartenary ground which soils are colmated at each year by the overflowing of the large rivers (Brasil, 1979).

The area climate is Afi belonging to the group of rainy tropical climate to the climatologic classification of Köppen (1948), cited by Ribeiro (1976): A - tropical climate practically without winter, whose average temperature to the colder month, never is under 18°C ; F- rain during the whole year; I - indicates isotherms, i.e., there is neither properly summer nor winter, as the annual oscillations of average temperature don't get 5°C. The distribution of the rains along the whole year has precipitation around of 2.000mm.

The metheorologic data observed in the period from 1991 to 1994, by the Meteorological Station of the Experimental Field of Caldeirão - EMBRAPA/CPAA, can be observed on the Table 2.

The regulation of Solimões river water from 1990 to 1997 presented the normal patterns, with an average in the maximum height in the overflowing of 28,02m , minimum in the low tide of 17,13m and amplitude of average change of 10,89m, according to Figure 1.

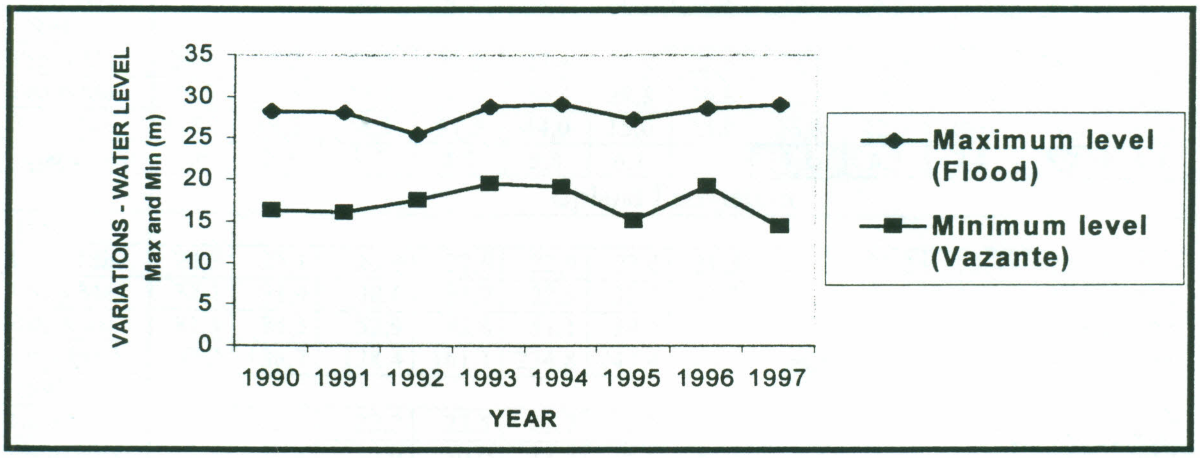

Figure 1 - Changes of the water's regulation of Solimões river at the period of 1990-1997.

The cultivation was carried out in a soil described and classified by Xavier et al (s/d) as Gley, little humic with silly texture on the classification of Plant and Soils Analysis Department of EMBRAPA/CPAA, the soil was collected on the surface of 0 to 20cm depth. The result of the fertility analysis and texture are presented in the Table 3.

Table 2 - Monthly averages of temperature, precipitation and solar bright at the Caldeirão region (floodplain ecosystem) in the period from 1991 to 1994 and on the upland ecosystem in the period from 1992 to 1996.

Event	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	Floodplain Ecosystem											
1991												
Temp Min	22,5	21,1	20,9	22,2	22,6	22,0	20,1	*	*	*	22,1	22,1
Temp Max	30,6	30,9	31,0	30,8	30,6	30,8	30,5	29,9	30,5	30,2	31,8	31,0
Prec Max	*	81,0	117,8	*	40,6	30,4	56,7	30,1	28,8	66,0	23,8	20,0
Solar bright	3,5	4,8	2,8	4,1	4,2	6,7	7,2	6,9	6,6	7,5	7,9	4,5
1992												
Temp Min	23,9	23,5	23,4	23,9	23,8	22,6	22,4	22,3	23,1	23,3	23,4	23,1
Temp Max	31,2	30,6	29,9	30,9	31,8	32,0	31,0	30,4	32,3	32,0	31,5	29,8
Prec Max	69,5	90,5	47,5	81,5	51,5	25,5	32,5	40,5	55,5	36,0	53,0	71,5
Solar bright	5,0	3,9	4,5	4,3	8,3	9,1	7,6	6,1	7,6	6,4	5,3	2,6
1993												
Temp Min	22,9	23,0	23,0	23,3	23,7	23,5	22,9	22,6	23,2	23,1	23,2	23,5
Temp Max	30,0	29,7	29,7	30,0	30,6	30,9	30,6	31,3	32,6	31,7	30,8	30,9
Prec Max	69,5	90,5	47,5	81,5	51,5	25,5	32,5	40,5	55,5	36,0	53,0	71,5
Solar bright	4,9	4,5	4,3	4,5	6,1	5,5	7,0	8,1	6,9	6,3	4,9	4,7
1994												
Temp Min	23,1	23,2	23,2	23,2	23,4	23,0	22,6	23,1	23,4	23,3	23,6	23,7
Temp Max	29,3	29,3	30,3	30,3	30,4	29,8	30,8	32,1	32,7	33,0	32,2	30,7
Prec Max	118,0	39,5	44,5	51,5	44,0	15,0	25,0	35,0	22,5	30,0	74,0	44,0
Solar bright	3,6	3,0	3,7	4,5	5,8	6,1	7,6	7,8	6,5	7,4	5,7	5,9
	Upland Ecosystem											
1992												
Temp Min	23,5	23,1	23,0	23,0	22,9	22,0	21,5	21,3	22,2	22,4	22,1	21,8
Temp Max	32,1	31,4	30,6	31,7	32,5	32,2	31,3	31,5	33,4	33,4	32,1	30,2
Prec Max	81,3	84,3	52,9	42,6	51,1	20,5	19,0	37,6	41,2	71,7	47,6	47,6
Solar bright	162,2	138,7	128,4	161,1	234,8	247,4	215,9	166,9	204,2	191,9	137,5	109,9
1993												
Temp Min	21,9	22,5	22,2	22,5	22,7	22,2	21,7	21,6	22,1	21,9	22,0	21,7
Temp Max	29,5	29,8	30,0	30,0	31,1	31,1	30,7	31,6	31,9	31,1	30,0	30,1
Prec Max	45,8	57,8	86,5	48,0	22,8	19,3	17,0	9,8	33,0	63,2	57,2	37,3
Solar bright	138,1	107,1	134,6	125,8	197,5	207,9	208,0	225,4	201,1	173,2	147,3	150,3
1994												
Temp Min	22,1	22,3	22,4	22,1	22,5	21,9	21,8	21,9	22,0	22,1	22,5	22,3
Temp Max	29,5	29,7	30,3	30,5	30,7	30,0	30,7	31,8	32,0	32,2	31,5	29,8
Prec Max	58,0	81,2	65,0	87,7	33,7	37,5	24,5	17,6	28,8	55,3	39,1	51,3
Solar bright	69,8	76,1	102,6	93,5	134,0	137,6	197,0	182,2	161,4	174,8	155,5	137,5
1995												
Temp Min	22,3	23,0	22,5	22,8	22,3	22,0	21,9	22,0	22,1	22,1	22,1	22,2
Temp Max	30,5	30,1	30,1	30,5	30,4	30,5	31,7	32,7	32,8	21,2	30,6	30,8
Prec Max	41,9	44,8	37,2	88,9	50,0	46,1	10,0	10,4	52,3	28,5	85,5	28,4
Solar bright	139,8	129,6	117,2	111,6	134,3	145,2	184,5	216,6	194,0	175,7	111,8	144,2
1996												
Temp Min	21,7	22,2	22,6	22,6	22,5	21,7	22,1	21,9	22,2	22,2	22,0	21,5
Temp Max	29,2	29,2	30,2	30,5	30,7	29,7	30,9	32,7	33,3	32,6	32,0	31,8
Prec Max	44,0	46,5	78,8	60,0	24,6	35,7	26,5	28,2	29,7	20,0	49,6	57,2
Solar bright	91,8	90,8	112,7	107,2	120,6	95,2	127,2	146,6	131,1	127,6	120,5	83,7

* broken instrument

UPLAND ECOSSYSTEM (Small Tree)

The sumauma's cultivation was carried out in January 1992 in upland ecosystem of experimental field of EMBRAPA/CPAA on lines on full soil, with 10 trees on the spacing of 3,0m between plants and 3,0m lines, located at Km 24 of AM-010 Highway (Manaus-Itacoatiara). The area is located between the coordinates $59^0$52'40" and $59^0$58'00"of east longitude and $03^0$00'00" of south latitude (Ribeiro,1976). It was cut two trees and was carried out measurements of total height (Ht) and diameter at breast height (DBH) according table 1.

According Ribeiro (1976), the climate of the area belongs to the tropical rainy group, classified as type Afi according Köppen, characterized to present average temperature never under 18^0 C; rains during the whole year, indicating isotherms, once that the annual oscillations of average temperature don't reach 5^0C, there isn't either properly summer or winter and the precipitation of the drier month is superior to 60mm.

The climatologic data observed in the period of 1991 to 1996 by the Meteorological Station of EMBRAPA/CPAA, are contained on table 2.

The type of soil occurring in the area is characterized as yellow latossol, texture very clay, with pH around 4,5 (Pamplona et al, 1995). On the classification of the Plant and Soil Analysis Department of EMBRAPA/CPPA the soil was collected on the surface of 0 to 20 cm depth whose results of fertility and texture are presented on Table 3.

Table 3 - Results of fertility analysis and physics of soil at the line of the plantation of sumauma floodplain , during August 14th, 1996 to August 14th, 1997 and upland on September, 1996.

Month	PH (H_2O)	P Ppm	K Ppm	Ca Me%	Mg Me%	Al Me%	C %	N %	Sand (%)		Clay Tot(%)	Silte (%)
									Coarse	Fine		
Floodplain Ecosystem												
09/96	5,02	30	92	14,34	3,57	0,762	1,038	0,29	0,55	3,22	27,35	68;88
10/96	4,92	92	98	11,08	2,94	0,609	1,015	0,27	1,13	13,49	19,35	66,03
11/96	4,75	40	98	12,99	3,38	1,227	1,187	0,29	0,36	3,81	28,05	67,78
12/96	4,90	38	110	14,12	3,61	0,897	1,156	0,29	0,64	3,16	28,20	68,00
01/97	4,92	72	116	13,11	3,38	0,702	0,935	0,28	0,66	6,97	22,80	69,57
02/97	5,09	36	104	12,77	3,15	0,955	1,164	0,33	0,35	3,02	28,00	68,63
03/97	5,19	33	100	14,06	3,44	0,824	1,049	0,28	0,49	3,95	26,75	68,81
04/97	5,39	36	116	15,13	3,28	0,390	1,132	0,27	0,99	2,96	28,85	67,20
07/97	4,93	29	118	11,82	3,15	1,100	-	0,130	0,61	2,81	31,50	65,08
08/97	5,35	22	106	12,56	3,05	0,820	-	0,137	0,98	2,54	28,20	68,28
Upland ecosystem												
08/96	4,70	11	24	0,67	0,14	1,50	2,03	0,21	0,93	3,24	31,32	64,51

Physical and anatomic properties of wood

- DENSITY DETERMINATION

It was prepared samples 1x1x1cm according Schuster (1996) obtaining also the change of density in the sense of the pith.

The methodology used to determine the density was 0% of humidity, according Resende et al (1993).

- DETERMINATION OF ANISOTROPY COEFFICIENT

The anisotropy coefficient is given by radial, tangential and linear shrinkage ratio. The samples used for this assay were the same at the apparent density. For the measurements were carried out by using the micrometer. The humid dry and humid volume were obtained maintaining the samples in the freezer. Dry weight and volume were obtained by drying oven at 103 ± 2^0C.

- ANATOMIC CHARACTERISTICS

For the anatomical microscopic description of wood also prepared samples ,1x1x1cm according Schuster (1996).

They were prepared blocks sharply with orientation and the anatomical cut on the cross plane. The small blocks were put upon wax to prevent its rupture when the histological cut. It was a sliding microtome with nominal binocular with of 30µm. The samples were colored by safranin and astra blue and they were mounted under permanent blade by using "Entellan".

- REQUIREMENT FOR ANATOMICAL MICROSCOPY CHARACTERIZATION

For anatomical characterization the structure of sumauma, followed COPANT Norm (1974). It was observed the frequency of vessels, rays, fibers and parenchyma, with magnification of 10x, coupled the binocular microscopy Bausch & Lomb. The measurements of vessels, rays, fibers and parenchymas were converted by a correction factor 2x.

RESULT AND DISCUSSION

Several factors affect the physical and anatomical properties of wood, due to the heterogeneity, being therefore difficult to control, and others easily controlled.

The Figure 2, shows the variation of density in the direction of the pith - bark, even in the wild sumauma as in those planted in floodplain and in the upland. The density increases in this direction showing minimal values 0,11g/cm^3 and maximum of 0,43 g/cm^3. Nevertheless, at the wild species, the density showed a tendency of decrease next to the bark. Similar results were described by Amaral et al (1971) and with *Araucaria angustifolia* and Rolim and Ferreira (1974).

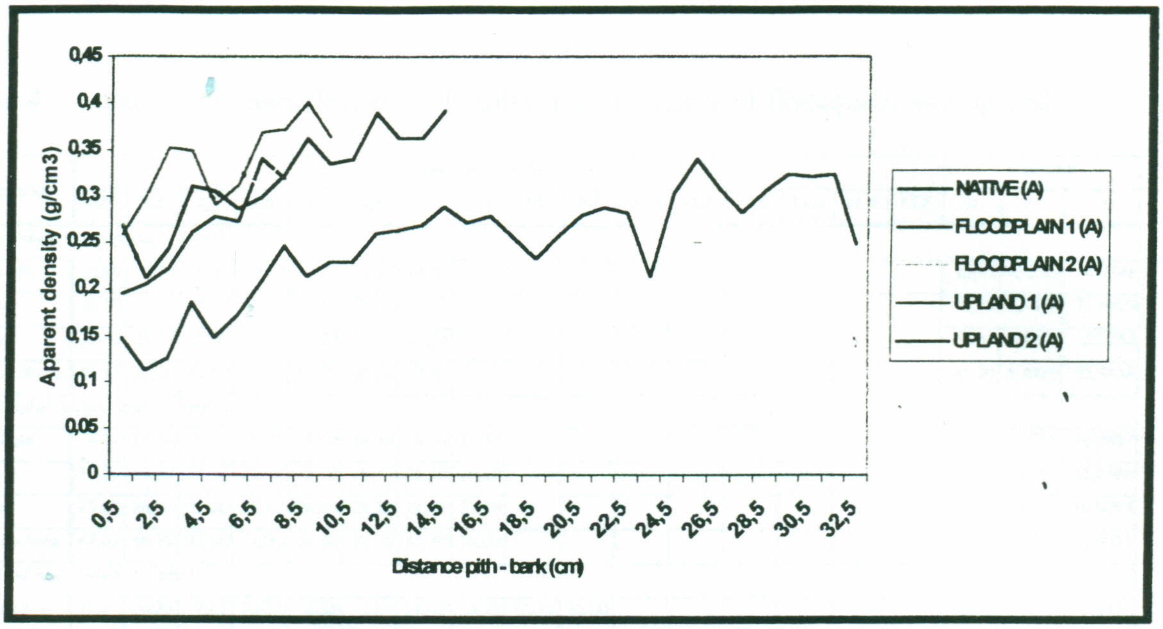

Figure 2 - Change of apparent density at the direction pith - bark, at the sumauma wood of foodplain, upland and native (A).

By observing the environments it was verified that the planted tree at he upland, followed the floodpain ecosystem showed higher values than the wild sumauma. It is likely that this behavior be due the environment at once that this factor influences the anatomical structure of the wood and its density. The Figure 3 and Table 4 show the frequency of the vessels and rays in per cent is relatively constant within the tree and the environment.

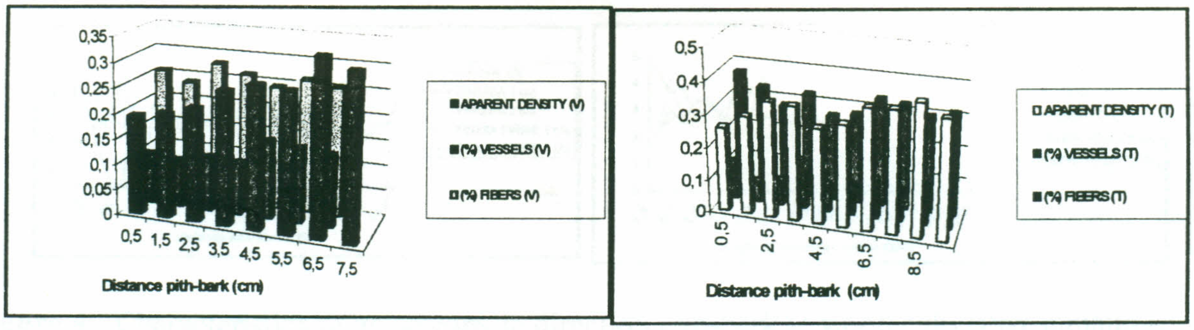

Figure 3 - Variation of density, fibers and vessels in per cent of cultivated wood at the floodplain (V) and upland (T) ecosystem, in the direction pith-bark.

cultivated wood, considering the density seems to differ a little of the quality of the native wood, when this parameter is considered. The low density of native wood trees is favorable the plywood manufacture with low cost. These results could limitate the future use of the cultivated tree in both ecosystem.

In other hand, the higher density, present on the cultivations will favor the production of plywood, more resistant, and consequently could be used to manufacture product of better quality. It will allow, also, the use of the wood with low density, on the superior and inferior surface (cover) of the plywood, what probably will compensate the increase of the costs above described.

Tabela 5 – Estimated values for the density at cultivated sumauma ecosystem of floodplain and upland, and native sumauma.

Ecosystem	Equation	R^2	Estimated Density (g/m^3)	Observed Density (g/m^3)
Upland 1	Y = 0,0377Ln(x)+0,286	0,608	0,417	-
Upland 2	Y = 0,0457Ln(x)+0,24	0,677	0,400	-
Foodplain (1)	Y = 0,0514Ln(x)+0,2034	0,782	0,382	-
Foodplain (2)	Y = 0,044Ln(x)+0,2389	0,891	0,392	
Native	Y = 0,0533Ln(x)+0,1152	0,749	0,301	0,248

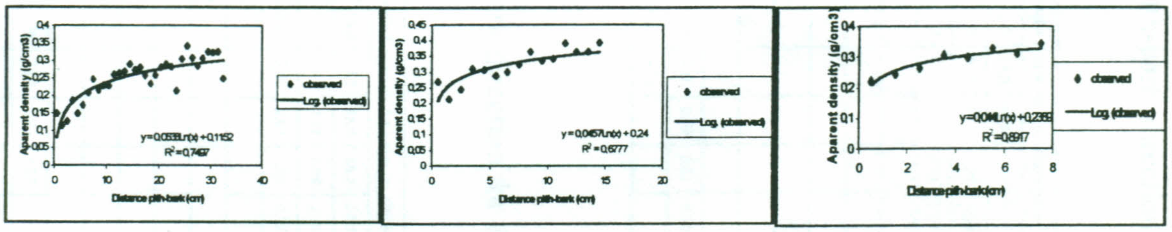

Figure 5 - Filled regression equation for native sumauma and cultivated at the upland and floodplain ecosystem.

Table 6 - Radial variation of density (g/cm^3) on the pith-bark direction for sumauma cultivated trees at the floodplain and upland ecosystem.

Ecossistema	Direção	Variação Radial da Densidade (g/cm^3 (Direção medula – casca)																																Estatística		
		1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	16.5	17.5	18.5	19.5	20.5	21.5	22.5	23.5	24.5	25.5	26.5	27.5	28.5	29.5	30.5	31.5	32.5	μ	σ^2	σ
Nativa	A	0.11	0.13	0.18	0.15	0.17	0.21	0.25	0.21	0.23	0.23	0.26	0.26	0.27	0.29	0.27	0.28	0.26	0.23	0.26	0.28	0.29	0.28	0.21	0.30	0.34	0.31	0.28	0.31	0.32	0.32	0.32	0.25	0.25	0.004	0.059
	B	0.20	0.18	0.17	0.18	0.19	0.17	0.18	0.23	0.24	0.23	0.22	0.24	0.27	0.30	0.32	0.28	0.27	0.30	0.33	0.37	0.31	0.33	0.31	0.34	0.34								0.26	0.004	0.063
Várzea (1)	A	0.20	0.22	0.26	0.28	0.27	0.34	0.32																										0.26	0.003	0.053
	B	0.18	0.33	0.22	0.19	0.32																												0.24	0.005	0.070
Várzea (2)	A	0.24	0.26	0.31	0.30	0.33	0.31	0.34																										0.29	0.002	0.042
	B	0.24	0.28	0.31	0.35	0.39																												0.31	0.003	0.055
Terra firme (1)	A	0.30	0.35	0.35	0.29	0.31	0.37	0.37	0.40	0.36																								0.34	0.002	0.004
	B	0.27	0.31	0.33	0.36	0.32	0.31	0.36	0.32	0.33	0.41																							0.33	0.001	0.036
Terra firme (2)	A	0.21	0.24	0.31	0.31	0.29	0.30	0.32	0.36	0.33	0.34	0.39	0.36	0.36	0.36	0.39	0.21	0.30	0.34	0.31	0.28	0.31	0.32	0.32	0.32	0.25								0.32	0.003	0.005
	B	0.23	0.26	0.28	0.32	0.34	0.32	0.33	0.34	0.39	0.34	0.37	0.41	0.44	0.34																			0.33	0.004	0.060

Table 7 - Radial variation of the anisotropy on the pith-bark direction for the sumauma cultivated trees on the upland and floodplain and native floodplain ecosystem.

Ecossistema	Direção	Variação Radial da Anisotropia (Direção medula – casca)																															Estatística		
		1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	16.5	17.5	18.5	19.5	20.5	21.5	22.5	23.5	24.5	25.5	26.5	27.5	28.5	29.5	30.5	31.5	μ	σ^2	σ
Nativa	A	2,67	1,17	0,00	0,00	3,26	2,51	0,39	3,35	2,06	3,56	2,41	2,90	2,59	2,18	2,57	4,08	2,71	3,57	2,81	3,92	4,32	2,19	3,30	3,91	0,00	3,81	3,04	2,07	2,64	2,65	3,84	2,60	1,44	1,20
	B	1,96	3,04	2,55	3,37	3,45	2,43	3,98	2,71	4,43	2,65	2,74	3,07	2,63	2,40	2,61	2,25	2,77	2,95	2,46	3,11	2,90	2,66	3,26	2,34	3,62							2,89	0,31	0,56
Várzea (1)	A	1,68	1,97	3,33	4,88	2,87	0,00	3,14	2,35	-																							2,53	1,42	2,01
	B	2,11	2,67	2,76	3,32	3,31	2,93	-	-	-																							2,85	0,21	0,45
Várzea (2)	A	1,81	2,72	3,51	3,96	3,51	3,11	-	-	-																							3,10	0,57	0,75
	B	4,01	2,16	3,95	4,34	3,47	2,74	-	-	-																							3,45	0,70	0,83
Terra firme (1)	A	2,43	2,66	2,79	2,63	3,41	2,85	3,59	2,02	1,23	2,76																						2,64	0,44	0,66
	B	1,84	4,24	2,69	2,33	2,66	2,90	2,71	2,15	2,02	1,95																						2,55	0,48	0,69
Terra firme (2)	A	3,13	4,34	3,41	3,78	0,08	3,08	3,39	3,51	2,79	2,76	2,55	2,63	2,78	2,63	2,21	4,55																2,98	1,01	1,01
	B	4,58	3,69	3,82	2,72	3,21	2,66	2,57	3,78	2,88	2,46	2,84	0,00	0,00																			2,71	1,82	1,35

CONCLUSION

By regarding these results presented can conclude that:

- Cultivated trees at floodplain and upland ecosystem , as well as native trees, presented an increase of density on the pith-bark direction;
- The density was higher at cultivated tree on the upland ecosystem, following floodplain cultivated tree, when by comparison with native sumauma;
- The values of anisotropy coefficients of shrinkage met, they show that sumauma species is highly dimensionally unstable, showing therefore limitations for using window frames;
- The logarithmic model was the best fitted the data of density versus pith-bark distance;
- The influence of the ecosystems on the formation of the wood anatomic elements wasn't evident;
- The average datas estimated to the density, with the fitted regression equation by ecosystem, are higher than the measured to native sumauma.

REFERENCES

Amaral, ACB; Ferreira, M; and Bandel, G, 1971: Variação da densidade básica da madeira produzida pela *Araucaria angustifolia* (Bert.) ° Ktze no sentido medula casca em árvores do sexo masculino e feminino. Revista IPEF. Piracicaba, São Paulo. 2/3: 119-127 p.

Brasier, JD, 1977: The effect of forest pratices on quality of the harves. In: Forestry, v.50, p. 49-66.

Brasil. Ministério da Agricultura. Secretária Nacional de Planejamento Agrícola, 1979: Aptidão Agrícola das Terras do Amazonas. Estudos básicos para o planejamento agrícola, aptidão agrícola das Terras. 121. Brasília. 142 p.

Browning, BL, 1963: The Chemistry of wood. New York; John Wiley & Sons, 689 p.

Falesi, JC, 1986: Estado atual de conhecimento de solos da Amazônia brasileira. In: Anais do 1 ° Simpósio do Trópico Úmido, Belém, EMBRAPA/CPATU. V. 1, p. 168-191.

Fernandes, ECM, and Serrão, EAS, 1992: Protótipo de modelos Agropastoris Sustentáveis. In: Pará (Estado) – Secretaria de Estado de Ciência, Tecnologia e Meio Ambiente. Seminário Internacional sobre Meio Ambiente, Pobreza e Desenvolvimento. Anais, 16. Belém: PRODEKA. 254-251 p.

Galvão, APM, and Jankowsky, JP, 1985: Secagem racional da madeira. Nobel, 112 p.

Junk, W, 1989: The use of Amazonian floodplains under ecological perspective. Interciência, v. 14, n.6, p. 317-322.

Lamprecht, H, 1990: Silvicultura nos Trópicos: Ecossistemas florestais e respectivas espécies arbóreas – Possibilidades e métodos de aproveitamento sustentado, Dt. Ges fir Techn. Zusammenarbeit (GTZ) Gmbh, esclborn.

Larson, PR, 1962: A biological approach to wood quality, Tappi, v.45, p. 443-448.

Loureiro, AA; and Silva, MF da, 1968: Catálago das madeiras da Amazônia. Vol.1 e 2. Belém. p. 433 e 411.

Loureiro, AA, Silva, MF da; and Alencar, JC, 1979: Essências Madeireiras da Amazônia. Manaus – AM. INPA/SUFRAMA. V.2. 87 p.

Pamplona, AM; Andreazze, R; Azevedo, CP; and Lima, RMB, 1995: Registro de danos nas raízes de Mogno (*Swietenia macrophylla* KING). EMBRAPA/CPAA. Comunicado Técnico.

Resende, MA, SagliettI, JRC; and Martinez, JC, 1993: Estudo das variações da massa específica e retratibilidade da madeira do *Eucalyptus saligna.* Anais 1° Congresso Florestal Panamericano. 7 ° Congresso Florestal Brasileiro. V. 2. Curitiba. Paraná. 629-635 p.

Ribeiro, MNG, 1976: Os aspectos climatológicos de Manaus. Acta Amazônica, 6 (2): 229-233.

Rolim, MB; and Ferreira, M, 1974: Variação da densidade básica da madeira produzida pela *Araucaria angustifolia* (Bert.) ° Ktze em função dos anéis de crescimento. Revista IPEF. Piracicaba, São Paulo. N ° 9: 47-55 p.

Schubart, HOR, and Salati, E, 1982: Los usos de tierra en la Región Amazónica: Los sistemas Natulales. In: Investigación sobre agricultura y uso de tierras. Cali: CIAT. P. 219-249.

Schuster, F, 1996: Qualitative und quantitative Untersuchungen von *Carapa guianensis* Aubl. Im Hinblick auf eine Frühdiagnose für die Eigenschaften des Holzes von Plantagen in Amazonien. Universität Hamburg, Fachbereich Biologie. Hamburg. 103 p.

Shimoyama, VR, 1990: Variações da densidade básica e características anatômicas e químicas da madeira em *Eucalyptus spp.* Piracicaba/SP, ESALQ, 93 p, (Tese de Mestrado).

Veloso, HP, Rangel Filho, ALR, and Lima, JCA, 1991: Classificação da Vegetação Brasileira, adaptada a um sistema universal. Rio de Janeiro: IBGE. 124 p. 1991.

Vital, BR, 1984: Métodos de determinação da densidade de madeira. Viçosa, MG, SIF, 21 p., 1984.

Xavier, JBN; Amaral, I L, and Corrêa, JC, Imakawa, AM; Elias, M.E.A, Morais, RR, Melo, ZL DE O, Caracterização Florística em solos de Terra Firme e Várzea, em uma área do município de Iranduba – AM. (não publicado).