FEDERAL RURAL UNIVERSITY OF THE AMAZON
FOUNDATION FOR SUPPORTING RESEARCH EXTENSION AND TEACHING IN AGRARIAN SCIENCES
INTERNATIONAL TROPICAL TIMBER ORGANIZATION
COMPANY BATISFLOR FLORESTAL LTDA

ECOLOGY AND SILVICULTURE OF MAHOGANY (*Swietenia macrophylla,* KING) IN THE WESTERN BRAZILIAN AMAZON

Phase II
Post-harvesting activities

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INTRODUCTION

The present study aims to establish silvicultural practices, for managing natural forests with occurrence of mahogany (*Swietenia macrophylla* King), and to suggest possible changes in the current federal legislation (IN n° 07/2003), which regulates preparation of Forest Management Plans for areas of tropical forest in the Brazilian Amazon with the occurrence of mahogany.

This research project was developed in an Annual Production Unit (UPA) of a forest management plan of the Fazenda Seringal Novo Macapá, located in Southern Amazonas State, bordering the State of Acre on the left bank of the Purus River.

As a strategy for implementing the project, an institutional partnership among the Rural Federal University of the Amazon (UFRA), the International Tropical Timber Organization (ITTO), the Foundation for Supporting Research Extension and Teaching in Agrarian Sciences (FUNPEA) and a private company the Batisflor Florestal Ltda was formed.

Project activities were divided into two phases, the first "Phase I" (pre-harvesting activities), consisted of activities carried out before the harvesting of the area, according to a forest management plan approved by the environmental agency (Brazilian Institute of Environment and Renewable Natural Resources - IBAMA) and the "Phase II" (post-harvesting activities), measurement of plots after the completion of Phase I.

Although, the Phase I activities were all developed within the period of project duration (24 months), whose results were submitted as a partial report to the funding agency (ITTO), the implementation of activities of Phase II were postponed due to the delay in the forest management plan approval and the consequent issuance of logging permit (Autorização para Exploração Florestal - AUTEF) by the environmental agency (IBAMA/AC). For this reason, only after 18 months of the completion of Phase I, it was possible to conduct field work relating to Phase II. This report refers only to post-harvesting activities developed under the Phase II of the project.

This report presents data processing and analysis related to the first and second measurement of Permanent Sample Plots-PSP (Parcelas Permanentes - PP) and evaluation plots of dispersion of mahogany natural regeneration (plantules and seedlings). The results of Phase II data were then compared with the results of Phase I. The field data collection of Phase II was conducted immediately after logging. For this reason, it was not possible to evaluate the effect of light incidence in the forest due to canopy opening caused by logging and roads construction; therefore, these data do not reflect the effect of logging on growth and recruitment of mahogany plantules and seedlings. But, it is possible to make inferences about damage caused by logging activities, in stocks of natural regeneration (plantules and seedlings) of mahogany, in the project area.

This report is divided into two chapters: Chapter I examines the phytosociology of the area, through the analysis of permanent sample plots; and Chapter II analyzes mahogany natural regeneration (plantules and seedlings).

CHAPTER I

PHYTOSOCIOLOGY OF THE AREA THROUGH THE ANALYSIS OF PERMANENT SAMPLE PLOTS.

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FIRST MEASUREMENT OF PERMANENT SAMPLE PLOTS (Phase I - Pre-harvesting)

In the Phase I – Pre-harvesting, the phytosociological analysis of forest with occurrence of mahogany was carried out with data obtained from a field survey of 8 permanent sample plots (PSP) of 0.25 ha (10 x 250 m), in the UPA-1R, which was presented in the Phase I Report. The result shows that there was a total of 511 individuals distributed among 108 species in the sampled area, and out of those only eight species (cacau "cocoa" (*Theobroma sp*), canela "cinnamon" (*Ocotea sp*), Cocão (*Attalea Tessmannii*), Freijó (*Brazilian Walnut* / *Cordia goeldiana* Huber.), Inga (*Inga sp*), João mole (*Guapira Opposita*), N.I., Muitatinga da folha miúda "Pama" (*Brosimum lactecens, S. Moore, C.C. Berg*) presented number of individuals greater than or equal to 10, representing 47.75%, of the inventoried individuals, and 38 species presented only one (1) individual, equivalent to only 7.44% of the total abundance.

1. SECOND MEASUREMENT OF PERMANENT SAMPLE PLOTS (Phase II - Post-Harvesting)

2.1. FLORISTIC ANALYSIS OF THE AREA

In the second measurement of permanent sample plots (PP), as in the first measurement, 8 permanent sample plots referring to individuals of the tree stratum (individuals with DBH ≥ 10 cm) were remeasured and natural regeneration consisting of young trees stratum (individuals with 5.0 ≤ DBH < 10.0 cm), plantules (with individuals with 2.5 ≤ DBH < 5.0 cm) and seedlings (individuals with height ≥ 30 cm and DBH < 2.5 cm).

In this field survey, 47 botanical families in the tree stratum were found, the 10 families with large numbers of individuals, excluding not identified (N.I.) families, with 17 individuals were the following: Fabaceae (18.53%), Malvaceae (16.39%), Moraceae (9.03%), Meliaceae (5.22%), Apocynaceae (4.75%), Salicaceae (4.51%), Sapotaceae (3.56%), Rubiaceae (3.32%), Lauraceae (3.09%) and Nyctaginacea (2.61%) which together are responsible for 71% of total individuals inventoried. Figure 1 shows botanical families with their respective numbers of individuals occurring in the sampled area.

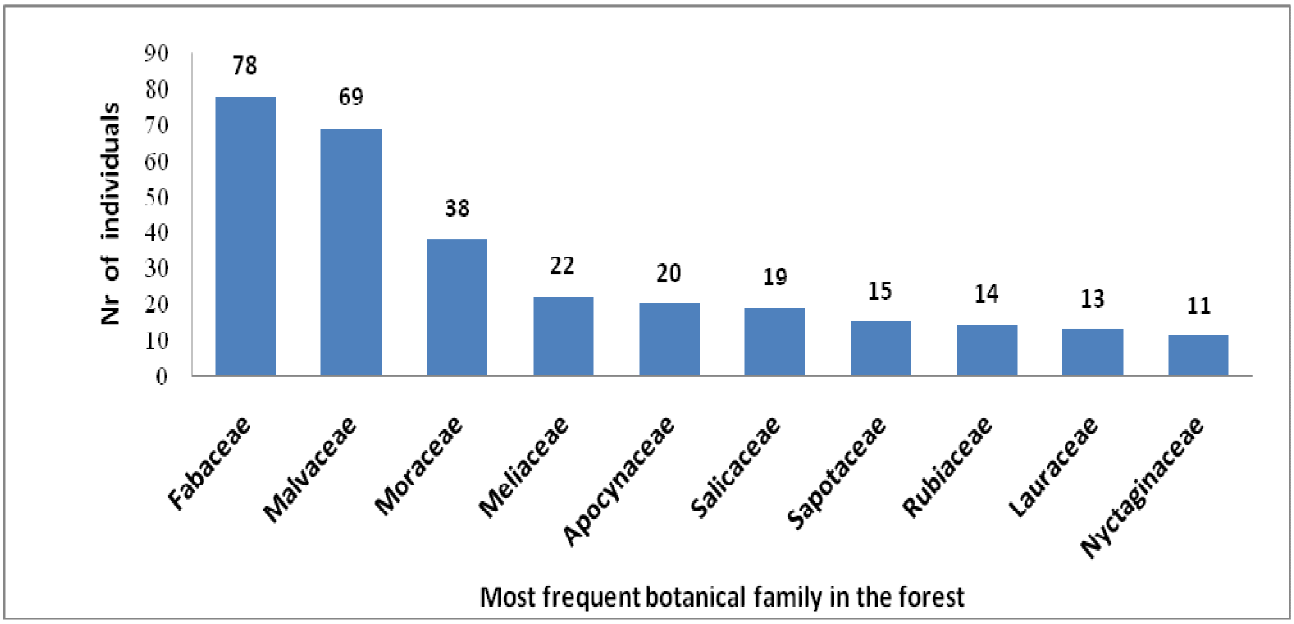

Figure 1. Botanical plant families found in Phase II (Post–harvesting), in the Fazenda Seringal Novo Macapá, with their respective numbers of individuals.

Fabaceae, Moraceae, Lauraceae, and Sapotaceae included among the 10 most abundant families found in the Fazenda Seringal Novo Macapá (Figure 1), located in the State of Acre, also appear in the list of the most abundant in the study "Phytosociology of a part of upland forest in the Western Amazon – Indigenous land “Nove de Janeiro/AM, Brazil” (Fotopoulos 2006), carried out in Porto Velho municipality, in Rondônia State, such as: Moraceae and Sapotaceae with 60 individuals each (13.36%), Burseraceae with 55 individuals (12.25%), Sterculiaceae with 46 (10.24%) and Tiliaceae with 12 individuals (2.67%).

In the tree stratum 421 individuals were tallied distributed in 122 species, where the smallest diameter at breast height (DBH) found was 10.03 cm of Caúcho (*Helicostylis turbinata* C.C.Berg) species, while the largest diameter was for mahogany (*Swietenia macrophylla* King) species. Table 1 shows that Caúcho species, even though it presented the smallest DBH of measured population, was classified at the 17th position of the Importance Value Index IVI (%). This is due to the fact that in the parameters for Abundance, Dominance and Frequency, placed the 14th, 17th and 13th, respectively, and it can be inferred that its contribution is significant in the formation of phytosociological structure of the forest. On the other hand, mahogany contributed only with 3 individuals, and thus it placed 36th and 35th positions in the parameters relating to Abundance and Frequency, respectively, however it is the species with larger Dominance (32,85 $m^2.ha^{-1)}$, presenting a value that reached the 1st place in the ranking of Importance Value Index - IVI (%) and Cover Value Index - IVC (%).

The total number of individuals found for the population was 210.5 $ind.ha^{-1}$ whereas the basal area (G) was 14.054 $m^2.ha^{-1}$.

Table 1. Vegetation´s structural parameters of the Fazenda Seringal Novo Macapá, Manoel Urbano municipality in Acre, for the tree stratum (DBH ≥ 10 cm): Absolute abundance, Aabs (Nº of ind.ha^{-1}); Relative abundance, Arel (%); Absolute dominance Dabs (m².ha^{-1}); Relative dominance Drel. (%); Absolute Frequency, Fabs (%); Relative Frequency, Frel (%); Cover Value Index, IVC (%); Importance Value Index, IVI (%).

Nº	Common Name	Scientific Name	Aabs	Arel (%)	Dabs m²/ha	Drel (%)	Fabs (%)	Frel (%)	IVC (%)	IVI (%)
1	Mogno / Mahogany	Swietenia macrophylla King	1,5	0,713	1,6428	11,458	1,5	0,716	12,17	12,886
2	Cachuá	Trichilia macrophylla Berth	8	3,800	0,1327	0,926	13	6,205	4,726	10,932
3	Passarinheira FG/ Casearia	Casearia javitensis Kunth	9,5	4,513	0,2454	1,711	9	4,296	6,225	10,520
4	Mututi of upland / bloodwood	Pterocarpus rohrii Vahl	9,5	4,513	0,2293	1,599	9	4,296	6,112	10,408
5	Muiratinga FM / Brosimum	Brosimum lactescens	9	4,276	0,2304	1,607	9	4,296	5,883	10,178
6	Mamorana da Terra Firme	Bombacopsis trinitensis (Urb.) A. Robyns	6,5	3,088	0,4459	3,110	6,5	3,103	6,197	9,300
7	Araracanga	Aspidosperma eteanum Markgr.	3,5	1,663	0,7488	5,223	3,5	1,671	6,885	8,556
8	inajá-rana	Quararibea guianensis A ubl.	8,5	4,038	0,1157	0,807	7,5	3,580	4,845	8,425
9	Samaúma / kapok	Ceiba pentandra (L.) Gaertn.	2,5	1,188	0,7129	4,972	2	0,955	6,160	7,114
10	Ingápeludo	Inga barbata Benth.	4	1,900	0,4188	2,921	4	1,909	4,821	6,731
11	Fava Atanã	Parkia gigantocarpa Ducke	3	1,425	0,5235	3,651	3	1,432	5,076	6,508
12	João Mole	Neea floribunda Poepp. & Endl.	5,5	2,613	0,0864	0,603	5,5	2,625	3,215	5,841
13	Tabocão	Coccoloba ascendens Duss ex Lindau	4	1,900	0,2,295	1,601	4	1,909	3,501	5,410
14	Bofe de Anta	Cavanillesia Ruiz & Pav.	2,5	1,188	0,4,113	2,869	2,5	1,193	4,056	5,250
15	Freijó	Cordia goeldiana Huber	3,5	1,663	0,2735	1,908	3,5	1,671	3,570	5,241
16	Cacauí	Theobroma speciosum Willd. ex Spreng.	5	2,375	0,0636	0,444	5	2,387	2,819	5,206
17	Apuí	Ficus gameleira Standl.	0,5	0,238	0,6698	4,672	0,5	0,239	4,909	5,148
18	Caúcho	Helicostylis turbinata C.C.Berg	3,5	1,663	0,2366	1,650	3,5	1,671	3,313	4,984
19	Mata-Mata Jibóia	Eschweilera carinata S.A.Mori	2,5	1,188	0,3338	2,328	2,5	1,193	3,516	4,709
20	Tapereba	Spondias mombin L.	3	1,425	0,2337	1,630	3	1,432	3,055	4,487
21	Abiurana Vermelho	Pouteria manaosensis (Aubrév. & Pellegr.) T.D.Penn.	4,5	2,138	0,0160	0,112	4,5	2,148	2,250	4,398
22	Carapanaúba	Aspidosperma nitidum Benth. ex Müll.Arg.	3	1,425	0,2204	1,537	3	1,432	2,962	4,394
23	Tamanqueira Folha graúda	Zanthoxylum riedelianum Engl.	2,5	1,188	0,2881	2,010	2,5	1,193	3,197	4,391
24	Jutaí Mirim	Hymenaea parvifolia Huber	1	0,475	0,4913	3,427	1	0,477	3,902	4,379
25	Gombeira	Swartzia panacoco (Aubl.) R.S.Cowan	3	1,425	0,1744	1,217	3	1,432	2,642	4,074
26	Erva de rato	Palicourea guianensis Aubl.	4	1,900	0,5706	0,398	3,5	1,671	2,298	3,969
27	Pata de vaca	Bauhinia bicuspidata Benth.	3,5	1,663	0,1213	0,846	3	1,432	2,509	3,941
28	Ingá vermelho	Inga edulis Mart.	3	1,425	0,1273	0,888	3	1,432	2,313	3,745
29	Seringueira	Hevea brasiliensis	2	0,950	0,2620	1,827	2	0,955	2,778	3,732

		(Willd. ex A. Juss.) Müll. Arg.								
30	Cerejeira	NI	1	0,475	0,3556	2,480	1	0,477	2,955	3,433
31	Janitá	Brosimum guianense (Aubl.) Huber	2,5	1,188	0,1405	0,980	2,5	1,193	2,167	3,361
32	Burra Leiteira	Sapium marmieri Huber	2,5	1,188	0,1130	0,788	2,5	1,193	1,976	3,169
33	Bucheira	Matisia cordata Bonpl.	2,5	1,188	0,0851	0,593	2,5	1,193	1,781	2,974
34	Louro Branco	Ocotea amazonica (Meisn.) Mez	2,5	1,188	0,0811	0,566	2,5	1,193	1,754	2,947
35	Mugumba	Pseudobombax munguba (Mart. & Zucc.) Dugand	2	0,950	0,1386	0,967	2	0,955	1,917	2,871
36	Guariúba	Clarisia racemosa Ruiz & Pav.	2	0,950	0,1143	0,797	2	0,955	1,747	2,702
37	Sterculia	Sterculia speciosa K. Schum.	1,5	0,713	0,1550	1,081	1,5	0,716	1,794	2,510
38	Açoita Cavalo	Luehea cymulosa Spruce ex Benth.ymulosa Spruce	0,5	0,238	0,2905	2,026	0,5	0,239	2,264	2,502
39	Macacaúba	Platymiscium trinitatis Benth.	1,5	0,713	0,1489	1,038	1,5	0,716	1,751	2,467
40	Caripé	Licania membranacea Sagot ex Laness.	2	0,950	0,0706	0,493	2	0,955	1,443	2,397
41	Mururé	Brosimum acutifolium Huber	1,5	0,713	0,1374	0,959	1,5	0,716	1,671	2,387
42	Fava Branca	Parkia ulei (Harms) Kuhlm. var. ulei	0,5	0,238	0,2634	1,837	0,5	0,239	2,075	2,313
43	Maparajuba	Manilkara cavalcantei Pi res & W.A.Rodrigues ex T.D.P enn.	1,5	0,713	0,1204	0,840	1,5	0,716	1,553	2,269
44	Sucuba	Himatanthus sucuuba (Spruce ex Müll.Arg.) Woodson	2,5	1,188	0,0434	0,303	1,5	0,716	1,490	2,206
45	3 Folhas	Metrodorea flavida K.Krause	2	0,950	0,0404	0,282	2	0,955	1,232	2,187
46	Mamuí	Jacaratia spinosa (Aubl.) A. DC.	1	0,475	0,1608	1,121	1	0,477	1,597	2,074
47	Acariquara	Minquartia guianensis Aubl.	1,5	0,713	0,0913	0,637	1,5	0,716	1,350	2,066
48	Axixá	Sterculia pruriens var. pruriens	1,5	0,713	0,0692	0,482	1,5	0,716	1,195	1,911
49	Mulungum	NI	1,5	0,713	0,0567	0,396	1,5	0,716	1,108	1,824
50	Andirobarana	Guarea kunthiana A.Juss.	1,5	0,713	0,0440	0,307	1,5	0,716	1,020	1,736
51	Louro amarelo	Aniba citrifolia (Nees) Mez	1,5	0,713	0,0384	0,268	1,5	0,716	0,981	1,697
52	Bacuri Pari	Rheedia macrophylla (Mart.) Planch. & Triana	1,5	0,713	0,0339	0,236	1,5	0,716	0,949	1,665
53	Fava Amargosa	Vatairea erythrocarpa (Ducke) Ducke	1,5	0,713	0,0321	0,224	1,5	0,716	0,937	1,653
54	Freijó Branco	Cordia bicolor A.DC.	1,5	0,713	0,0275	0,192	1,5	0,716	0,905	1,621
55	Abiurana	Pouteria guianensis Aubl.	0,5	0,238	0,1622	1,132	0,5	0,239	1,369	1,608
56	Farinha Seca	Lindackeria paludosa (Benth.) Gilg	1,5	0,713	0,0229	0,160	1,5	0,716	0,873	1,589
57	Envira Preta	Guatteria poeppigiana Mart.	1,5	0,713	0,0550	0,384	1	0,477	1,096	1,574
58	Macucú	NI	1	0,475	0,0883	0,616	1	0,477	1,091	1,568
59	Pajurá	Couepia paraensis (Mart . & Zucc.) Benth. subsp. paraensis	1	0,475	0,0745	0,520	1	0,477	0,995	1,472
60	Itauba	Mezilaurus itauba (Meisn.) Taub. ex Mez	1	0,475	0,0627	0,437	1	0,477	0,912	1,390
61	Jutaí pororoca	Dialium guianense (Aubl.) Sandwith	1	0,475	0,0616	0,430	1	0,477	0,905	1,382

62	Espinheiro Preto	NI	1	0,475	0,0402	0,281	1	0,477	0,756	1,233
63	Piquiá	Caryocar villosum (Aubl.) Pers.	1	0,475	0,0395	0,276	1	0,477	0,751	1,228
64	Tento Amarelo	Ormosia paraensis Ducke	0,5	0,238	0,1069	0,746	0,5	0,239	0,983	1,222
65	Pau de Bicho	Tapura guianensis Aubl.	1	0,475	0,0338	0,236	1	0,477	0,711	1,188
66	Muiracatiara	Astronium lecointei Ducke	0,5	0,238	0,0993	0,692	0,5	0,239	0,930	1,169
67	Ipê amarelo	Handroanthus serratifolius (A.H.Gentry) S.Grose	1	0,475	0,0294	0,205	1	0,477	0,680	1,157
68	Embaúbão	Pourouma guianensis Aubl.	1	0,475	0,0228	0,159	1	0,477	0,634	1,111
69	Grão de galo	Tabernaemontana rupicola Benth.	1	0,475	0,0191	0,133	1	0,477	0,609	1,086
70	Jenipapo	Genipa americana L.	1	0,475	0,0170	0,119	1	0,477	0,594	1,071
71	Caqui	Diospyros melinonii (Hiern) A.C.Sm.	1	0,475	0,0166	0,116	1	0,477	0,591	1,068
72	Bacabinha	Ferdinandusa elliptica (Pohl) Pohl	1	0,475	0,0159	0,111	1	0,477	0,586	1,064
73	Jeniparana	Gustavia augusta L.	1	0,475	0,0135	0,094	1	0,477	0,569	1,047
74	Conduru	Bocageopsis multiflora (Mart.) R.E.Fr.	1	0,475	0,0123	0,086	1	0,477	0,561	1,039
75	Catinga de Cutia	Duguetia flagellaris Huber	1	0,475	0,0113	0,079	1	0,477	0,554	1,031
76	Tachi Vermelho	Sclerolobium myrmecophilum Ducke	1	0,475	0,0108	0,075	1	0,477	0,551	1,028
77	Tarumã	Vitex triflora Vahl	1	0,475	0,0103	0,072	1	0,477	0,547	1,024
78	Murta	Eugenia amazonica O.B erg	1	0,475	0,0099	0,069	1	0,477	0,544	1,021
79	Cacau	Theobroma cacao L.	1	0,475	0,0085	0,059	1	0,477	0,534	1,012
80	Cumarú	Dipteryx odorata (Aubl.) Willd.	0,5	0,238	0,0674	0,470	0,5	0,239	0,708	0,946
81	Louro capitiú	Licaria amara (Mez) Kosterm.	0,5	0,238	0,0604	0,421	0,5	0,239	0,659	0,897
82	Jacaranda do Pará	Dalbergia glauca (Desv.) Amshoff	1	0,475	0,1640	0,114	0,5	0,239	0,589	0,828
83	Ingá de Porco	Abarema laeta (Benth.) Barneby & J.W.Grimes	1	0,475	0,0144	0,100	0,5	0,239	0,575	0,814
84	Marupá	Simarouba amara Aubl.	0,5	0,238	0,0433	0,302	0,5	0,239	0,539	0,778
85	Pau de Balsa	NI	0,5	0,238	0,0409	0,285	0,5	0,239	0,522	0,761
86	Envira cana	Xylopia nitida Dunal	0,5	0,238	0,0392	0,274	0,5	0,239	0,511	0,750
87	Envira Bobo	Rollinia insignis R.E.Fr.	0,5	0,238	0,0350	0,245	0,5	0,239	0,482	0,721
88	Pau branco	NI	0,5	0,238	0,0340	0,237	0,5	0,239	0,474	0,713
89	Ucuubarana	Iryanthera juruensis Warb.	0,5	0,238	0,0304	0,212	0,5	0,239	0,450	0,688
90	Embaúba (Branca)	Cecropia obtusa Trécul	0,5	0,238	0,0254	0,177	0,5	0,239	0,415	0,654
91	Lacrão	NI	0,5	0,238	0,0244	0,170	0,5	0,239	0,408	0,646
92	Tinteiro	Miconia surinamensis Gleason	0,5	0,238	0,0198	0,138	0,5	0,239	0,376	0,614
93	Louro FG	Ocotea grandifolia (Nees) Mez	0,5	0,238	0,0182	0,127	0,5	0,239	0,365	0,604
94	Goiabarana	Psidium guineense Sw.	0,5	0,238	0,0161	0,112	0,5	0,239	0,350	0,588
95	Bálsamo	NI	0,5	0,238	0,0141	0,099	0,5	0,239	0,336	0,575
96	Cafezinho	Psychotria ernestii K.Krause	0,5	0,238	0,0127	0,089	0,5	0,239	0,327	0,565
97	Taquari	NI	0,5	0,238	0,0123	0,086	0,5	0,239	0,323	0,562
98	Breu Branco	Protium pallidum Cuatrec.	0,5	0,238	0,0108	0,075	0,5	0,239	0,313	0,552

99	Comida de Jabuti	Eugenia coffeifolia DC.	0,5	0,238	0,0108	0,075	0,5	0,239	0,313	0,552
100	Saboeira	Pithecellobium jupunba (Willd.) Urb.	0,5	0,238	0,0106	0,074	0,5	0,239	0,312	0,550
101	Pau Jacaré	Laetia procera (Poepp.) Eichler	0,5	0,238	0,0098	0,068	0,5	0,239	0,306	0,545
102	Casca seca	Couepia canomensis (Mart.) Benth. ex Hook.f	0,5	0,238	0,0090	0,063	0,5	0,239	0,301	0,539
103	Fava Bolacha	Vatairea paraensis Ducke	0,5	0,238	0,0085	0,059	0,5	0,239	0,297	0,535
104	Myrtaceae	Myrcia bracteata (Rich.) DC.	0,5	0,238	0,0083	0,058	0,5	0,239	0,295	0,534
105	Sucupira	Bowdichia nitida Spruce ex Benth.	0,5	0,238	0,0079	0,055	0,5	0,239	0,293	0,532
106	Maria Preta	Ziziphus cotinifolia Reissek	0,5	0,238	0,0076	0,053	0,5	0,239	0,291	0,529
107	Sapota	Sterculia speciosa K. Schum.	0,5	0,238	00,072	0,051	0,5	0,239	0,288	0,527
108	Gema de Ovo	Poecilanthe effusa (Huber) Ducke	0,5	0,238	0,0072	0,050	0,5	0,239	0,287	0,526
109	Ingá Grande	Inga grandiflora Ducke	0,5	0,238	0,0071	0,049	0,5	0,239	0,287	0,526
110	Pitomba	Talisia eximia K.U. Kramer	0,5	0,238	0,0069	0,048	0,5	0,239	0,286	0,525
111	Quarubarana	NI	0,5	0,238	0,0068	0,048	0,5	0,239	0,285	0,524
112	Rubiaceae	Psychotria barbiflora DC.	0,5	0,238	0,0066	0,046	0,5	0,239	0,284	0,522
113	Pente de Macaco	Apeiba tibourbou Aubl.	0,5	0,238	0,0058	0,041	0,5	0,239	0,278	0,517
114	Louro rosa	Aniba canelilla (Kunth) Mez	0,5	0,238	0,0057	0,040	0,5	0,239	0,277	0,516
115	Capoteiro	NI	0,5	0,238	0,0054	0,037	0,5	0,239	0,275	0,514
116	Papo de Mutum	Lacunaria crenata (Tul.) A.C.Sm.	0,5	0,238	0,0005	0,033	0,5	0,239	0,270	0,509
117	Envira Branca	Rollinia edulis Triana & Planch.	0,5	0,238	0,0045	0,032	0,5	0,239	0,269	0,508
118	Jarana	NI	0,5	0,238	0,0045	0,032	0,5	0,239	0,269	0,508
119	Goiabão	Pouteria bilocularis (H.J.P. Winkl.) Baehni	0,5	0,238	0,0044	0,031	0,5	0,239	0,268	0,507
120	Jatobá	Hymenaea courbaril L.	0,5	0,238	0,0440	0,031	0,5	0,239	0,268	0,507
121	Copaíba	Copaifera coriacea Mart.	0,5	0,238	0,0044	0,031	0,5	0,239	0,268	0,507
122	Canela de Jacamim	*Rinorea racemosa* (Mart.) Kuntze	0,5	0,238	0,0040	0,028	0,5	0,239	0,266	0,504
TOTAL GERAL			**210,5**	**100**	**14,338**	**100**	209	100	200	300

The ten most important species in the forest structural assessment, that is, species that presented High Importance Value Index, IVI (%) and the most expressive number of individuals found for each species in the studied area, in descending order were: *Swietenia macrophylla*, King (3), *Trichilia, macrophylla* Benth. (16), *Casearia javitensis*, Kunth (19), *Pterocarpus rohrii* Vahl, (19), *Brosimum lactescens*, (S. Moore) C.C.Berg (18), *Bombacopsis trinitensis* (Urb.) A. Robyns (13), *Aspidosperma eteanum* Markgr. (7), *Quararibea guianensis* Aubl. (17), *Ceiba pentandra* (L.) Gaertn. (4), *Inga barbata,* Benth, (8), (Figure 2A and 2B).

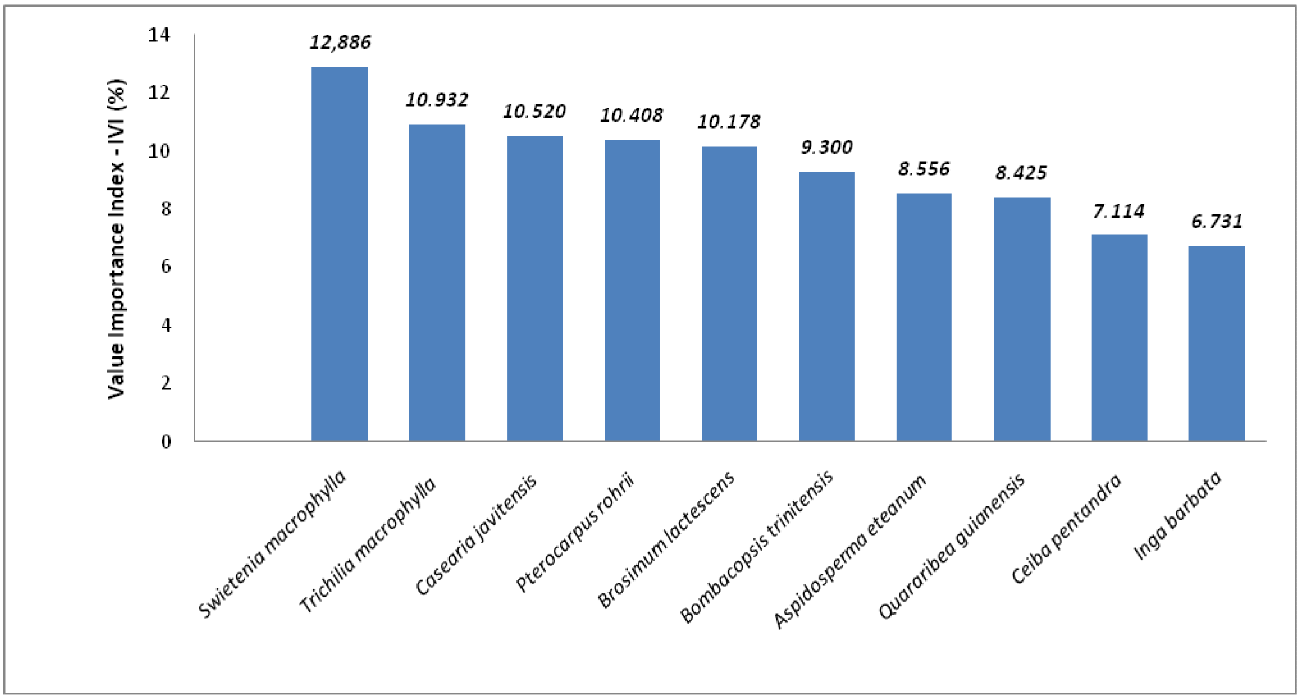

Figure 2A. Ten species of High Importance Value Index, IVI (%) of the Fazenda Seringal Novo Macapá, AC of the tree stratum.

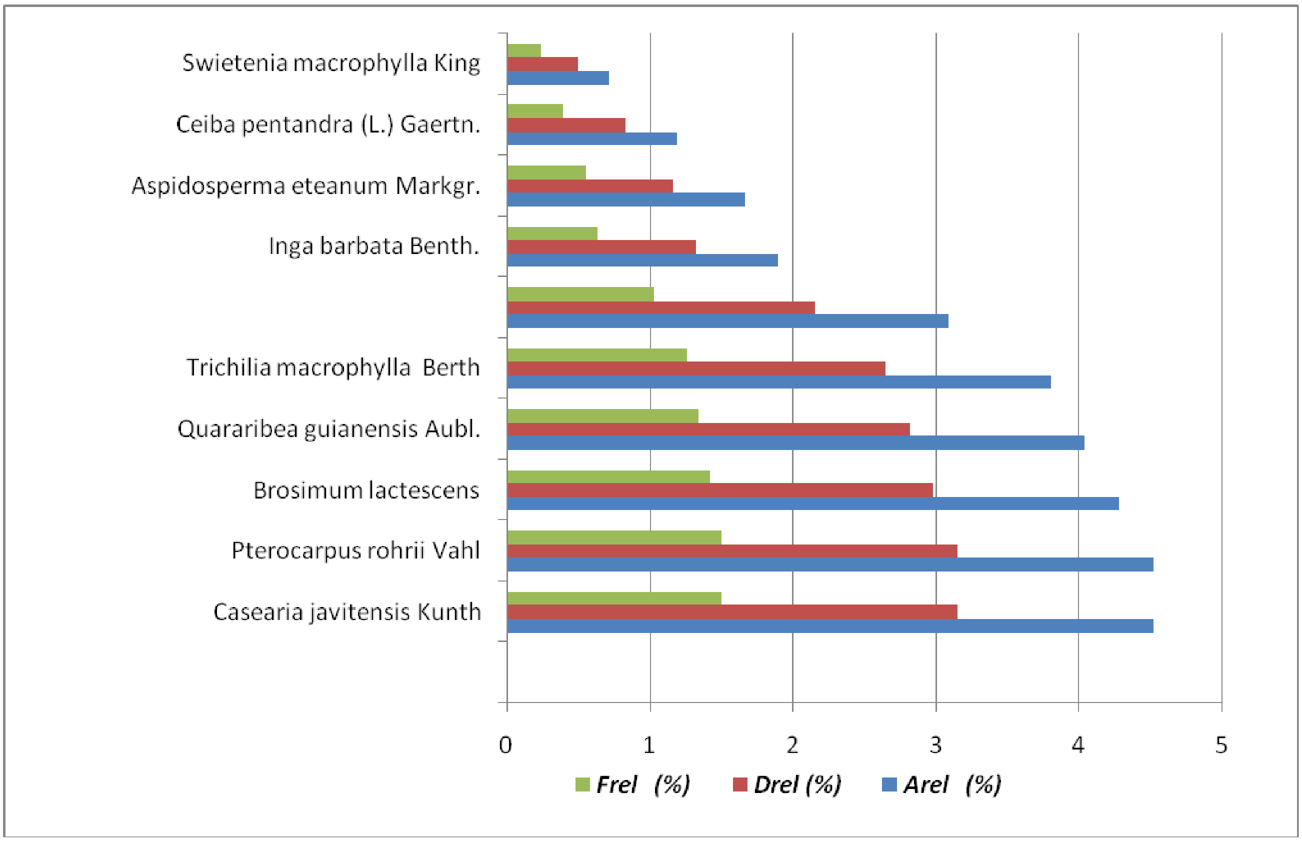

Figure 2B. Phytosociological parameters of species with high IVI of the Fazenda Seringal Novo Macapá, AC of the tree stratum.

2.2. STOCKS OF NATURAL REGENERATION OF YOUNG TREES, PLANTULES AND SEEDLINGS STRATA

a) Young Trees Stratum (5.0 cm ≤ DBH **<** 10.0 cm)

In the young trees stratum 207 individuals distributed in 76 species were found, out of which 7 species have been identified only by common names. Among them the most prominent species was *Rinorea racemosa* (Mart.) Kuntze reaching the highest IVI (%), and the lowest was a species identified only by the common name as “Pau branco”, with IVI 4.43%. The botanical identification of 7 species was not carried out because of the difficulties to collect botanical material for subsequent identification in the herbarium.

Rinorea racemosa (Mart.) Kuntze presented a stock of 37.5 ind.ha^{-1}, where all individuals were reinventoried, contributing with 7.73 % of the total. The species "Pau branco" presented only one individual, with 0.48 % of the total inventoried, corresponding to 2.5 ind.ha^{-1}.

Rinorea racemosa (Mart.) Kuntze occurred in all strata and was the most abundant species in the area, except for the tree stratum, as shown in Tables (2, 3, and 4). Table 3 shows that in the plantule stratum, 200 ind.ha^{-1} were found, which represents over 18% of the total plantule population. This species represents a large portion of the abundance of the forest, and therefore contributing to soil shading, which reduces bamboo growth and other light demanding species such mahogany, which compete with other species for nutrients and light.

It is important to know the occurrence of all tree species (floristic richness) in the area, not only commercial species, but also, those species that contribute to the community for ecological benefits to the forest, and its surrounding areas. The implementation of silvicultural treatments minimizes obstacles that hamper natural regeneration, and stimulate growth of potential crop species.

Table 2. Vegetation´s structural parameters of the Fazenda Seringal Novo Macapá, Manoel Urbano municipality in Acre, for young tree stratum (5.0 ≤ DBH < 10.0 cm): Absolute Abundance, Aabs (Nr. of ind.ha^{-1}); Relative Abundance, Arel (%); Absolute Dominance Dabs (m².ha^{-1}); Relative Dominance Drel. (%); Absolute Frequency, Fabs (%); Relative Frequency, Frel (%); Cover Value Index, IVC (%); Importance Value Index, IVI (%).

Nº	Scientific Name	Aabs (nr..ind/ha)	Arel (%)	Dabs (m²/ha)	Drel (%)	Fabs (%)	Frel (%)	IVC (%)	IVI (%)
1	***Rinorea racemosa* (Mart.) Kuntze**	**37,5**	**7,282**	**0,129**	**6,106**	**40,000**	**8,122**	**13,388**	**21,509**
2	***Pouteria guianensis* Aubl.**	**35**	**6,796**	**0,153**	**7,242**	**35,000**	**7,107**	**14,039**	**21,145**
3	***Casearia javitensis* Kunth**	**25**	**4,854**	**0,093**	**4,419**	**25,000**	**5,076**	**9,273**	**14,349**
4	***Pterocarpus rohrii* Vahl**	**17,5**	**3,398**	**0,081**	**3,835**	**17,500**	**3,553**	**7,233**	**10,786**

5	*Pouteria manaosensis* (Aubrév. & Pellegr.) T.D.Penn.	20	3,883	0,059	2,803	20,000	4,061	6,686	10,747
6	*Neea floribunda* Poepp. & Endl.	17,5	3,398	0,063	2,980	17,500	3,553	6,379	9,932
7	*Quararibea guianensis* Aubl.	15	2,913	0,061	2,893	15,000	3,046	5,805	8,851
8	*Brosimum lactescens* (S. Moore) C.C. Berg	15	2,913	0,070	3,313	12,500	2,538	6,226	8,764
9	*Talisia eximia* K.U. Kramer	12,5	2,427	0,049	2,330	12,500	2,538	4,757	7,296
10	*Zygia* P.Browne	12,5	2,427	0,043	2,029	12,500	2,538	4,456	6,994
11	*Guarea kunthiana* A.Juss.	10	1,942	0,054	2,548	10,000	2,030	4,489	6,520
12	*Metrodorea flavida* K.Krause	10	1,942	0,052	2,461	10,000	2,030	4,402	6,433
13	*Trichilia macrophylla* Benth.	10	1,942	0,051	2,412	10,000	2,030	4,354	6,384
14	*Eugenia amazonica* O.Berg	12,5	2,427	0,037	1,764	10,000	2,030	4,191	6,222
15	Vitex triflora Vahl	12,5	2,427	0,047	2,243	7,500	1,523	4,671	6,193
16	Licaria amara (Mez) Kosterm.	10	1,942	0,046	2,186	10,000	2,030	4,128	6,158
17	Duguetia flagellaris Huber	10	1,942	0,042	1,975	10,000	2,030	3,916	5,947
18	Coccoloba ascendens Duss ex Lindau	10	1,942	0,046	2,203	7,500	1,523	4,145	5,668
19	*Brosimum* guianense (Aubl.) Huber	7,5	1,456	0,040	1,888	7,500	1,523	3,344	4,867
20	Theobroma cacao L.	7,5	1,456	0,037	1,741	7,500	1,523	3,197	4,720
21	Brosimum guianense (Aubl.) Huber	7,5	1,456	0,036	1,722	7,500	1,523	3,178	4,701
22	Aniba canelilla (Kunth) Mez	7,5	1,456	0,035	1,665	7,500	1,523	3,121	4,644
23	Ceiba pentandra (L.) Gaertn.	7,5	1,456	0,033	1,541	5,000	1,015	2,997	4,013
24	Matisia cordata Bonpl.	7,5	1,456	0,021	0,990	7,500	1,523	2,446	3,969
25	Protium puncticulatum J.F.Macbr.	7,5	1,456	0,020	0,936	7,500	1,523	2,392	3,915
26	Genipa americana L.	7,5	1,456	0,028	1,351	5,000	1,015	2,807	3,822
27	Palicourea guianensis Aubl.	5	0,971	0,028	1,311	5,000	1,015	2,281	3,297
28	Guatteria poeppigiana Mart.	5	0,971	0,026	1,246	5,000	1,015	2,217	3,233
29	Vatairea erythrocarpa (Ducke) Ducke	5	0,971	0,025	1,190	5,000	1,015	2,161	3,176
30	Sclerolobium myrmecophilum Ducke	5	0,971	0,023	1,112	5,000	1,015	2,083	3,098
31	Tapura guianensis Aubl.	5	0,971	0,023	1,088	5,000	1,015	2,058	3,074
32	Swartzia panacoco (Aubl.) R.S.Cowan	5	0,971	0,022	1,045	5,000	1,015	2,016	3,031
33	Protium robustum (Swart) D.M.Porter	5	0,971	0,021	0,998	5,000	1,015	1,968	2,984
34	*Oxandra riedeliana* R.E.Fr.	5	0,971	0,021	0,982	5,000	1,015	1,953	2,968
35	*Clavija* lancifolia Desf.	7,5	1,456	0,021	1,002	2,500	0,508	2,458	2,966
36	*Iryanthera* juruensis Warb.	5	0,971	0,020	0,924	5,000	1,015	1,895	2,911
37	*Lacunaria crenata* (Tul.) A.C.Sm.	5	0,971	0,018	0,831	5,000	1,015	1,802	2,817
38	*Bocageopsis* multiflora (Mart.) R.E.Fr.	5	0,971	0,017	0,812	5,000	1,015	1,783	2,798
39	*Astronium lecointei* Ducke	5	0,971	0,024	1,144	2,500	0,508	2,115	2,622
40	*Inga edulis* Mart.	5	0,971	0,011	0,545	5,000	1,015	1,516	2,531
41	Platymiscium trinitatis Benth.	2,5	0,485	0,019	0,906	2,500	0,508	1,392	1,899
42	*Hevea brasiliensis* (Willd. ex A.Juss.) Müll.Arg.	2,5	0,485	0,019	0,906	2,500	0,508	1,392	1,899
43	*Senna leandrii* (Ghesq.) Du Puy	2,5	0,485	0,019	0,877	2,500	0,508	1,363	1,870
44	*Ficus gameleira* Standl.	2,5	0,485	0,018	0,849	2,500	0,508	1,334	1,842
45	*Couepia canomensis* (Mart.) Benth. ex Hook.f.	2,5	0,485	0,017	0,821	2,500	0,508	1,306	1,814

46	*Aspidosperma nitidum* Benth. ex Müll.Arg.	2,5	0,485	0,016	0,739	2,500	0,508	1,225	1,732
47	NI –Not Identified	2,5	0,485	0,015	0,687	2,500	0,508	1,173	1,680
48	*Lecythis idatimon* Aubl.	2,5	0,485	0,015	0,687	2,500	0,508	1,173	1,680
49	NI –Not Identified	2,5	0,485	0,013	0,637	2,500	0,508	1,123	1,630
50	NI –Not Identified	2,5	0,485	0,012	0,589	2,500	0,508	1,075	1,582
51	NI –Not Identified	2,5	0,485	0,012	0,589	2,500	0,508	1,075	1,582
52	*Eschweilera bracteosa* (Poepp. ex O. Berg) Miers	2,5	0,485	0,012	0,589	2,500	0,508	1,075	1,582
53	*Tachigali myrmecophila* (Ducke) Ducke	2,5	0,485	0,012	0,575	2,500	0,508	1,061	1,568
54	*Vatairea paraensis* Ducke	2,5	0,485	0,012	0,566	2,500	0,508	1,051	1,559
55	NI –Not Identified	2,5	0,485	0,012	0,566	2,500	0,508	1,051	1,559
56	*Xylopia nitida* Dunal	2,5	0,485	0,012	0,566	2,500	0,508	1,051	1,559
57	*Clarisia racemosa Ruiz & Pav.*	2,5	0,485	0,011	0,521	2,500	0,508	1,006	1,514
58	*Casearia pitumba* Sleumer	2,5	0,485	0,010	0,477	2,500	0,508	0,963	1,470
59	*Diospyros melinonii* (Hiern) A.C.Sm.	2,5	0,485	0,009	0,436	2,500	0,508	0,921	1,429
60	*Zanthoxylum riedelianum* Engl.	2,5	0,485	0,009	0,416	2,500	0,508	0,901	1,409
61	Virola michelii Heckel	2,5	0,485	0,009	0,416	2,500	0,508	0,901	1,409
62	Inga chrysantha Ducke	2,5	0,485	0,008	0,396	2,500	0,508	0,882	1,389
63	*Eschweilera carinata* S.A.Mori	2,5	0,485	0,008	0,377	2,500	0,508	0,863	1,370
64	*Erythroxylum micranthum* Bong. ex Peyr.	2,5	0,485	0,007	0,340	2,500	0,508	0,826	1,333
65	*Lindackeria paludosa* (Benth.) Gilg	2,5	0,485	0,007	0,340	2,500	0,508	0,826	1,333
66	NI –Not Identified	2,5	0,485	0,007	0,340	2,500	0,508	0,826	1,333
67	*Himatanthus* sucuuba (Spruce ex Müll.Arg.) Woodson	2,5	0,485	0,007	0,340	2,500	0,508	0,826	1,333
68	*Ormosia paraensis* Ducke	2,5	0,485	0,007	0,340	2,500	0,508	0,826	1,333
69	Inga Mill.	2,5	0,485	0,007	0,323	2,500	0,508	0,808	1,316
70	*Manilkara* cavalcantei Pires &W.A.Rodrigues ex T.D.Penn.	2,5	0,485	0,007	0,323	2,500	0,508	0,808	1,316
71	*Spondias mombin* L.	2,5	0,485	0,007	0,323	2,500	0,508	0,808	1,316
72	*Poecilanthe effusa* (Huber) Ducke	2,5	0,485	0,006	0,305	2,500	0,508	0,791	1,299
73	*Rollinia edulis* Triana & Planch.	2,5	0,485	0,006	0,292	2,500	0,508	0,778	1,285
74	*Licania membranacea* Sagot ex Laness.	2,5	0,485	0,005	0,257	2,500	0,508	0,742	1,250
75	*Inga grandiflora* Ducke	2,5	0,485	0,005	0,241	2,500	0,508	0,727	1,234
76	NI –Not Identified	2,5	0,485	0,005	0,241	2,500	0,508	0,727	1,234
GRAND TOTAL		515		2,11		492,5		200,00	300,00

In the first measurement (Phase I), 58 species were found, while in the Phase II, 76 species were found.

Species of the young tree stratum that presented greater relevance in the forest community are represented in Figures 3A and 3B. The ten most important species in the structural evaluation, according to the Importance Value Index - IVI (%) and the number of individuals found for each species in the studied area, in ascending order are: *Zygia* p. Browne (5), *Talisia eximia* K.U. Kramer (5), *Brosimum lactescens* (s. Moore) C.C. Berg (6), *Quararibea* *guianensis* Aubl. (6), *Neea floribunda* Poepp. Endl. (7), *Pterocarpus rohrii* Vahl (7), *Pouteria manaosensis* (Aubrév. Pellegr.) T.D.Penn. (8), *Casearia javitensis* Kunth (10), *Pouteria guianensis* Aubl. (14), *Rinorea racemosa* (Mart.) Kuntze (15).

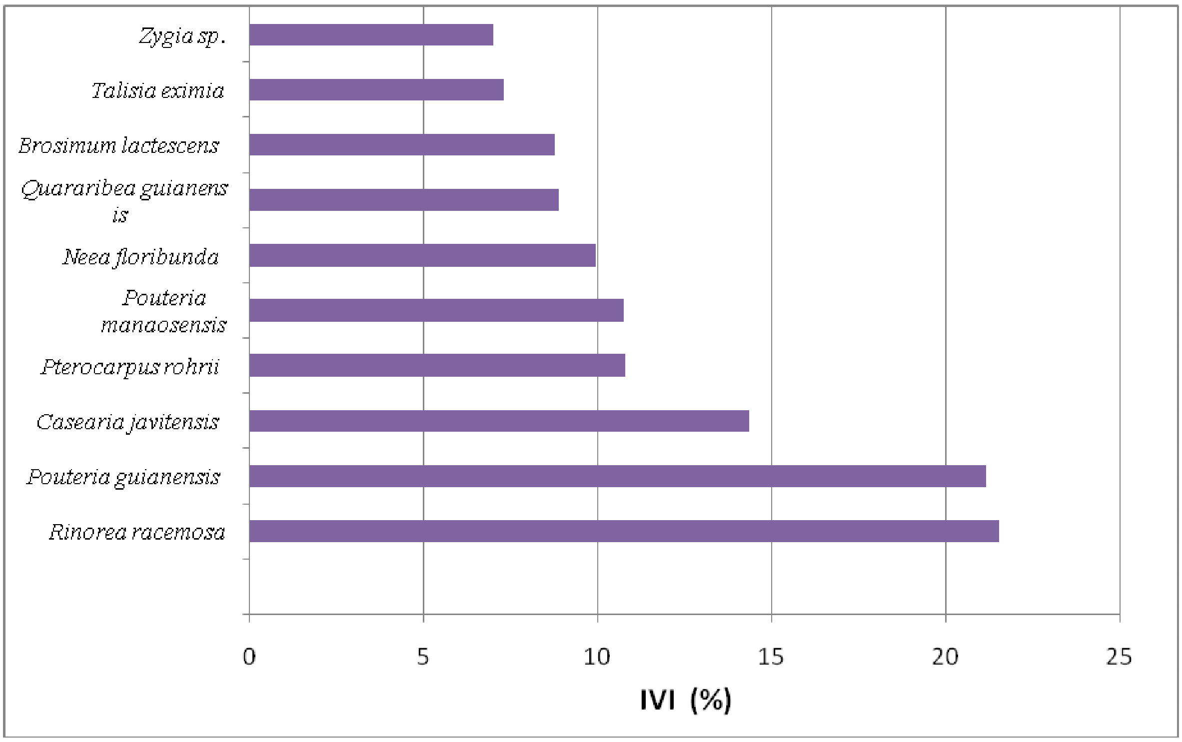

Figure 3A. Ten species of high importance value index IVI (%) of the Fazenda Seringal Novo Macapá, AC, of the young tree stratum.

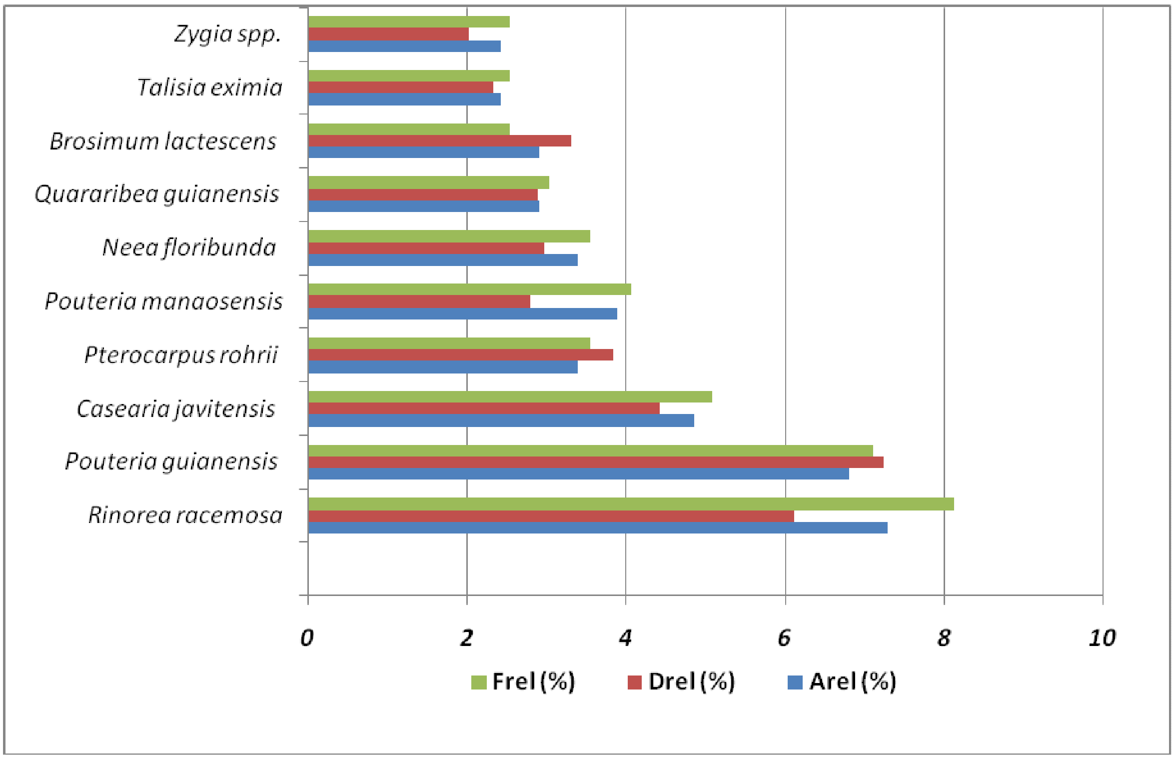

Figure 3B. Phytosociological parameters of species with high IVI of the Fazenda Seringal Novo Macapá, AC of the young tree stratum

b) Plantule Stratum (2.5 ≤ DBH **<** 5.0 cm)

The plantule stratum presents 76 individuals and 49 species. 51% Out of these, 51% have entered the young tree stratum and 71.43% reached the tree stratum. Thus, the regeneration stock in the saplimg stage is 28.5%.This includes Canela de Jacamin (*Rinorea racemosa*, (Mart.) Kuntze), Inajarana (*Quararibea guianensis* Aubl.) Passarinheira FG (*Casearia javitensis*, Kunth), Muiratinga FM (*Brosimum lactescens*) and Mututi (*Pterocarpus rohrii* Vahl,) that were the most abundant species.

Table 3. Vegetation´s structural parameters of the Fazenda Seringal Novo Macapá, Manoel Urbano municipality in Acre, for the plantule stratum (2.5 cm ≤ DBH < 5.0 cm): Absolute Abundance, Aabs (Nº of ind.ha^{-1}); Relative Abundance, Arel (%); Absolute Dominance Dabs (m².ha^{-1}); Relative Dominance Drel. (%); Absolute Frequency, Fabs (%); Relative Frequency, Frel (%); Cover Value Index, IVC (%); Importance Value Index, IVI (%).

Nº	Scientific Name	Aabs (ind/ha)	Arel (%)	Dabs (m²/ha)	Drel (%)	Fabs (%)	Frel (%)	IVC (%)	IVI (%)
1	Rinorea racemosa (Mart.) Kuntze	200	18,0180	0,0211	16,9446	27,5000	11,1111	34,9626	46,073
2	Pouteria guianensis Aubl.	80	7,2072	0,0088	7,0688	20,0000	8,0808	14,2760	22,356
3	Brosimum lactescens (S. Moore) C.C. Berg	50	4,5045	0,0060	4,8013	12,5000	5,0505	9,3058	14,356
4	Casearia javitensis Kunth	50	4,5045	0,0043	3,4699	10,0000	4,0404	7,9744	12,014
5	Pouteria manaosensis (Aubrév. & Pellegr.) T.D.Penn.	40	3,6036	0,0046	3,6851	10,0000	4,0404	7,2887	11,329
6	Rheedia macrophylla (Mart.) Planch. & Triana	30	2,7027	0,0042	3,3971	7,5000	3,0303	6,0998	9,130
7	Swartzia panacoco (Aubl.) R.S.Cowan	30	2,7027	0,0041	3,2887	7,5000	3,0303	5,9914	9,021
8	Zygia P.Browne	30	2,7027	0,0039	3,1318	7,5000	3,0303	5,8345	8,864
9	*Pterocarpus rohrii* Vahl	30	2,7027	0,0051	4,1105	5,0000	2,0202	6,8132	8,833
10	Licaria amara (Mez) Kosterm.	30	2,7027	0,0032	2,6061	7,5000	3,0303	5,3088	8,339
11	Inga edulis Mart.	30	2,7027	0,0029	2,3569	7,5000	3,0303	5,0597	8,090
12	Guarea kunthiana A.Juss.	30	2,7027	0,0027	2,1349	7,5000	3,0303	4,8376	7,867
13	Erythrochiton brasiliensis Nees & Mart.	30	2,7027	0,0031	2,4540	5,0000	2,0202	5,1567	7,176
14	*Quararibea guianensis* Aubl.	20	1,8018	0,0029	2,3117	5,0000	2,0202	4,1135	6,133
15	Metrodorea flavida K.Krause	20	1,8018	0,0023	1,8636	5,0000	2,0202	3,6654	5,685
16	Trichilia macrophylla Benth.	20	1,8018	0,0021	1,6824	5,0000	2,0202	3,4842	5,504
17	Tabernaemontana rupicola Benth.	20	1,8018	0,0021	1,6581	5,0000	2,0202	3,4599	5,480
18	Eugenia amazonica O.Berg	20	1,8018	0,0019	1,4896	5,0000	2,0202	3,2914	5,311
19	Neea floribunda Poepp. & Endl.	20	1,8018	0,0017	1,3812	5,0000	2,0202	3,1830	5,203
20	Oxandra riedeliana R.E.Fr.	20	1,8018	0,0017	1,3669	5,0000	2,0202	3,1687	5,188
21	*Eschweilera* coriacea (DC.) S.A.Mori	20	1,8018	0,0016	1,2941	5,0000	2,0202	3,0959	5,116
22	*Laetia* procera	20	1,8018	0,0014	1,0935	5,0000	2,0202	2,8953	4,915

	(Poepp.) Eichler								
23	Duguetia flagellaris Huber	10	0,9009	0,0021	1,6565	2,5000	1,0101	2,5574	3,567
24	Copaifera coriacea Mart.	10	0,9009	0,0021	1,6565	2,5000	1,0101	2,5574	3,567
25	Cordia bicolor A.DC.	10	0,9009	0,0018	1,4559	2,5000	1,0101	2,3568	3,366
26	*Talisia eximia* K.U. Kramer	10	0,9009	0,0018	1,4559	2,5000	1,0101	2,3568	3,366
27	NI	10	0,9009	0,0016	1,2683	2,5000	1,0101	2,1692	3,179
28	Capparis coccolobifolia Mart.	10	0,9009	0,0016	1,2683	2,5000	1,0101	2,1692	3,179
29	Tapura guianensis Aubl.	10	0,9009	0,0016	1,2683	2,5000	1,0101	2,1692	3,179
30	*Clavija* lancifolia Desf.	10	0,9009	0,0015	1,1793	2,5000	1,0101	2,0802	3,090
31	Cavanillesia Ruiz & Pav.	10	0,9009	0,0014	1,0935	2,5000	1,0101	1,9944	3,004
32	Passiflora acuminata DC.	10	0,9009	0,0013	1,0110	2,5000	1,0101	1,9119	2,922
33	Psychotria ernesti Krause	10	0,9009	0,0012	0,9631	2,5000	1,0101	1,8640	2,874
34	Vitex triflora Vahl	10	0,9009	0,0012	0,9631	2,5000	1,0101	1,8640	2,874
35	Minquartia guianensis Aubl.	10	0,9009	0,0012	0,9318	2,5000	1,0101	1,8327	2,842
36	Eugenia coffeifolia DC.	10	0,9009	0,0012	0,9318	2,5000	1,0101	1,8327	2,842
37	*Inga* barbata Benth.	10	0,9009	0,0012	0,9318	2,5000	1,0101	1,8327	2,842
38	Lacunaria crenata (Tul.) A.C.Sm.	10	0,9009	0,0012	0,9318	2,5000	1,0101	1,8327	2,842
39	Guatteria poeppigiana Mart.	10	0,9009	0,0011	0,8858	2,5000	1,0101	1,7867	2,796
40	Inga Mill.	10	0,9009	0,0010	0,7830	2,5000	1,0101	1,6839	2,694
41	Siparuna guianensis Aubl.	10	0,9009	0,0010	0,7830	2,5000	1,0101	1,6839	2,694
42	NI	10	0,9009	0,0008	0,6471	2,5000	1,0101	1,5480	2,558
43	*Protium puncticulatum J.F.Macbr.*	10	0,9009	0,0008	0,6471	2,5000	1,0101	1,5480	2,558
44	Licania membranacea Sagot ex Laness.	10	0,9009	0,0008	0,6471	2,5000	1,0101	1,5480	2,558
45	Aniba canelilla (Kunth) Mez	10	0,9009	0,0008	0,6471	2,5000	1,0101	1,5480	2,558
46	Bombacopsis trinitensis (Urb.) A. Robyns	10	0,9009	0,0008	0,6471	2,5000	1,0101	1,5480	2,558
47	Sloanea laxiflora Spruce ex Benth.	10	0,9009	0,0008	0,6471	2,5000	1,0101	1,5480	2,558
48	Pseudobombax munguba (Mart. & Zucc.) Dugand	10	0,9009	0,0007	0,5840	2,5000	1,0101	1,4849	2,495
49	Poecilanthe effusa (Huber) Ducke	10	0,9009	0,0007	0,5241	2,5000	1,0101	1,4250	2,435

The ten most important species of the sampling stratum, according to the IVI – Importance Value Index were, in ascending order (number of individuals within brackets): *Licaria amara*, (Mez) Kosterm. (3), *Pterocarpus rohrii* Vahl (2), *Zygia*, p. Browne (3), *Swartzia panacoco*, (Aubl.) (3), R.S.Cowan (3), *Rheedia macrophylla* (Mart.) Planch. & Triana (3), *Pouteria manaosensis* (Aubrév. Pellegr.) T.D.Penn. (4), Casearia javitensis, Kunth (4), *Brosimum lactescens*, (S. Moore) C.C. Berg (5), *Pouteria guianensis* Aubl.(8), and *Rinorea racemosa*, (Mart.) Kuntze (15), (Figure 4A and 4B).

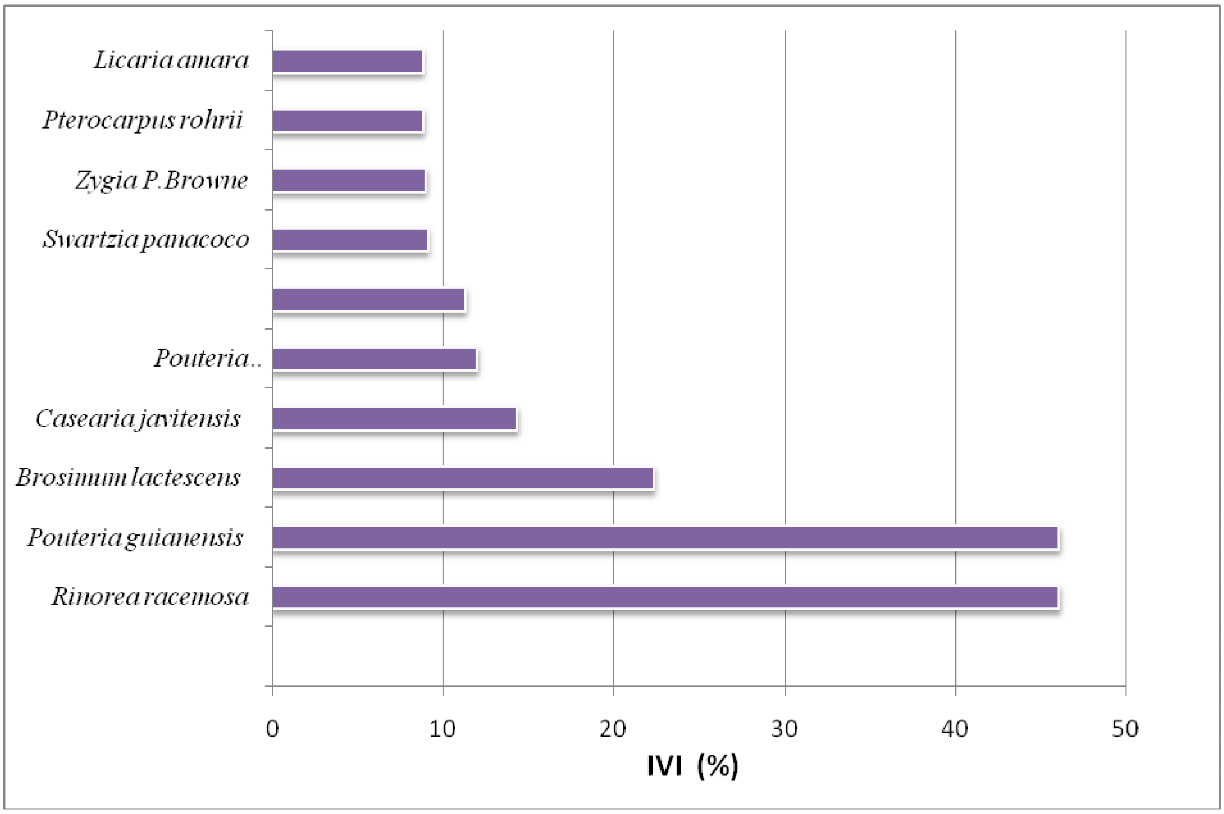

Figure 4A. Ten species of high importance value index IVI (%) of the Fazenda Seringal Novo Macapá, AC of the plantule stratum.

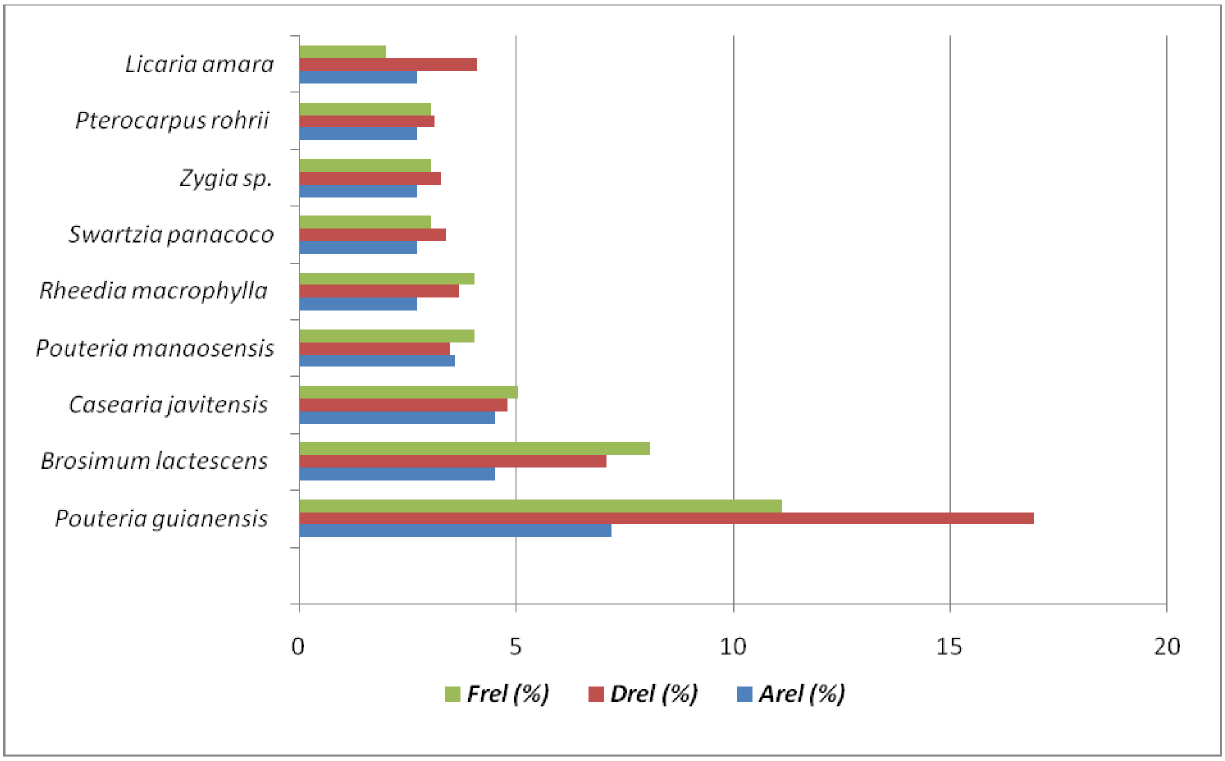

Figure 4B. Phytosociological parameters of species with high IVI of the Fazenda Seringal Novo Macapá, AC of the plantule stratum.

c) **Seedling Stratum (Height ≥ 30 cm and DBH < 2.5 cm)**

Only counting of individuals of each species was carried out in the seedling stratum (Height ≥ 30 cm and DBH < 2.5 cm). Eight-three individuals distributed in 37 species were recorded, and most of the species were also found in other strata, except for 4 species: Guarupá (NI – not identified); Marapuama (*Clavija lancifolia* Desf.); Quari-Quara da Terra Firme (NI) and the Tachi branco (*Sclerolobium eriopetalum* Ducke) which were only found in this stratum.

It was also observed that species found in the tree stratum occur in at least one of the other natural regeneration strata, but with different stock densities. The stock of species that presents seed dispersal problems or require specific conditions for t germination and growth is small as is the case of mahogany (*Swietenia macrophylla*, King). Mahogany, which is currently listed in CITES (Convention on International Trade in Species of Wild Flora and Fauna Threatened with Extinction) Appendix II, does not have difficulties to germinate. However, specific appropriate conditions for germination and establishment such as light and soil moisture are required.

Thus, the fact that mahogany was found only in the seedling stratum (Table 4), and absent in the plantule and young tree strata is justified, as bamboo (*Guadua* sp.) closes completely the lower canopy layer, making it difficult the incidence of light, reducing the survival rate and growth of mahogany seedlings. This jeopardizes stock for the following harvesting cycles. Application of appropriate silvicultural treatments are therefore required to assure the species establishment and replenishment of volume stocks.

Table 4. Abundance of seedling stratum of the Fazenda Seringal Novo Macapá, Manoel Urbano municipality in Acre for individuals with Height ≥ 30 cm and DBH < 2.5 cm.

Nr.	**Common Name**	**Scientific Name**	**Nr. of Indiv.**
1	Canela de jacamim	*Rinorea racemosa* (Mart.) Kuntze	17
2	Inga vermelho	*Inga edulis* Mart.	10
3	Ingá peludo	*Inga* barbata Benth.	6
4	Pata de vaca	*Bauhinia bicuspidata* Benth.	4
5	Breu Vermelho	*Protium* robustum (Swart) D.M.Porter	3
6	inajá-rana	*Quararibea guianensis* Aubl.	3
7	Muiratinga FM	*Brosimum lactescens* (S. Moore) C.C. Berg	3
8	Amarelão	*Apuleia leiocarpa* (Vogel) J.F.Macbr.	2
9	Copaíba	*Copaifera coriacea* Mart.	2
10	Grão de Galo	*Tabernaemontana rupicola* Benth.	2
11	João mole	*Neea floribunda* Poepp. & Endl.	2

12	***Mogno / mahogany***	*Swietenia macrophylla* King	2
13	Passarinheira FG	*Casearia javitensis* Kunth	2
14	Tabocão	*Coccoloba ascendens* Duss ex Lindau	2
15	Abiurana vermelha	*Pouteria manaosensis* (Aubrév. & Pellegr.) T.D.Penn.	1
16	Andirobarana	*Guarea kunthiana* A.Juss.	1
17	Bucheira	Matisia cordata Bonpl.	1
18	Cacau / cocoa	Theobroma cacao L.	1
19	Cacauí	Theobroma speciosum Willd. ex Spreng.	1
20	Cachuá	Trichilia macrophylla Benth.	1
21	Caripé	Licania membranacea Sagot ex Laness.	1
22	Comida de Mutum	*Erythrochiton brasiliensis* Nees & Mart.	1
23	Guariúba	*Clarisia racemosa Ruiz & Pav.*	1
24	Guarupá	NI	1
25	Ingá Ferro	Zygia P.Browne	1
26	Jacaranda do Pará	Dalbergia glauca (Desv.) Amshoff	1
27	Louro capitiú	Licaria amara (Mez) Kosterm.	1
28	Louro rosa	Aniba canelilla (Kunth) Mez	1
29	Maparajuba	Manilkara cavalcantei Pires & W.A.Rodrigues ex T.D.Penn.	1
30	Marapuama	*Clavija* lancifolia Desf.	1
31	Mata-matá jibóia	Eschweilera coriacea (DC.) S.A. Mori	1
32	Muiracatiara	Astronium lecointei Ducke	1
33	Murta	Eugenia amazonica O. Berg	1
34	Quari-Quara da Terra Firme	NI	1
35	Seringueira / rubber tree	Hevea brasiliensis (Willd. ex A.Juss.) Müll.Arg.	1
36	Tachi branco	Sclerolobium eriopetalum Ducke	1
37	Tarumã	Vitex triflora Vahl	1
	GRAND TOTAL		**83**

2. PRE- AND POST-HARVESTING ANALYSIS OF PERMANENT SAMPLE PLOTS

Assessment of permanent sample plots (PSP) during Phase I - Pre-harvesting, revealed a total of 1,277 individuals, whereas in Phase II the number dropped to only 822 individuals, a reduction of 35.63% in relation to Phase I, that is, 455 individuals died or were not found in the study area. So, there was a significant decrease in the diversity of the remaining forest, since diversity is directly linked to the number of individuals per species. The species most affected by the logging impacts were Canela de Jacamim (*Rinorea racemosa* (Mart.) Kuntze), a single individual of Cedro Marinheiro (*Guarea* sp.) found dead, Inga (Zygia P.Browne), Sangrio, Louro (*Licaria amara* (Mez) Kosterm) and Muiratinga-folha-miuda (*Maquira* sp.) when compared to the number of individuals found in Phase I.

Due to the short time interval between the harvesting of UPA-1R and re-measurements of the PSPs, it was not possible to analyze dynamics of the studied species. Only the impacts of forestry activities on natural regeneration were dealt with.

For the tree stratum (DBH ≥ 10 cm), out of 511 individuals tallied in Phase I, 79 (15.46%) died, and 22 (4.3%) were not found. Many of identification tags fixed in individual trees in the first measurement have not been found. The reasons are many, for example, due to logging activities such as felling and skidding; the ones that found were put back on its original place. As a result, there was a reduction of 19.57% in the tree stratum population, resulting in only 421 individuals measured in Phase II, of which 10 individuals were ingrowth into the tree stratum.

In the young tree stratum, 262 individuals were found during the first measurement; in the second measurement of 22 individuals died and 30 were not found, 10 individuals moved into the tree stratum and 7 were ingrowth from the young tree stratum, resulting in 207 individuals. Thus, the total number of individuals per hectare found in the young tree stratum was 655 $ind.ha^{-1}$ and basal area of 2.44 $m^2.ha^{-1}$. In the second measurement 515 $ind.ha^{-1}$ and 2.11 $m^2.ha^{-1}$ of basal area were found. This represents a reduction of 21.38% in the number of individuals and 13.52% in basal area, as compared to the measurements before harvesting.

For the plantule stratum, a total of 135 individuals and 34 species were found before harvesting, corresponding to 1,350 $ind.ha^{-1}$ and a basal area of 25 $m^2.ha^{-1}$, whereas after harvesting 49 species with a total of 111 individuals (1,110 $ind.ha^{-1}$) were found, representing a 10.37% decrease in the number of plantules. The basal area for that stratum was 1.24 $m^2.ha^{-1}$, representing a reduction of only 1%.

In the first measurement, 30 species were inventoried, distributes in 369 individuals In the seedling stratum 30 species distributed in 369 individuals were found in the first measurement, whereas in the second assessment after logging, 37 species were recorded distributed in only 83 individuals. Therefore a loss of nearly 78% of individuals was observed for this stratum.

3. FINAL CONSIDERATIONS

The results obtained showed that individuals with smaller diameters were the most affected by logging, notably in the seedling and plantule stratum.

Although individuals of the plantule stratum had, a heavy mortality after logging, they presented the highest basal area growth rates;

Concerning phytosociological parameters of the forest, before and after harvesting, it was observed an important increase in floristic richness (number of species) of the area, although there was also a sharp reduction in abundance (nº of ind.ha^{-1}) of the main species. This means a decrease in species diversity, given that it is directly related to the number of individuals of the species;

Canela de Jacamin (*Rinorea racemosa*), has shown an outstanding behavior as it occurred in all strata. It ranked first in IVI (%) in the strata of seedlings, plantule and young trees. However as a small-sized species, it ranked last in the tree stratum.

Mahogany has not occurred in the plantule and young trees strata, corroborating with what have been pointed out in the literature dealing with the species.

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CHAPTER II

NATURAL REGENERATION OF MAHOGANY (PLANTULES AND SEEDLINGS)

1. FOREST INVENTORY OF NATURAL REGENERATION OF *SWIETENIA MACROPHYLLA* KING (MAHOGANY), BEFORE HARVESTING.

1.1 Occurrences of Plantules and Seedlings at Different Distances from the Mother Tree, before harvesting (Phase I).

1.2 Occurrences of Plantules and Seedlings Depending on the Distances from Mother Tree, Before Harvesting.

2. GENERAL DATA OF LOGGING ACTIVITY

3. FOREST INVENTORY OF NATURAL REGENERATION OF *SWIETENIA MACROPHYLLA* KING (MAHOGANY), AFTER HARVESTING OF THE STUDYAREA.

3.1 Occurrences of Plantules and Seedlings at Different Distances from the Mother Tree, after Harvesting (Phase II).

3.2 Stocks of Plantules and Seedlings before and after Harvesting

3.3 Height Growth of Seedlings

3.4 Enrichment planting in Canopy gaps

4. FINAL CONSIDERATIONS

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1. FOREST INVENTORY OF NATURAL REGENERATION OF *SWIETENIA MACROPHYLLA* KING (MAHOGANY), BEFORE HARVESTING

1.1 Occurrences of plantules and seedlings at different distances from mother tree, before harvesting (Phase I).

As presented in Phase I report, seed dispersion and establishment of natural regeneration of *Swietenia macrophylla*, King were evaluated in 20 randomly selected mother trees. However, treefalls due to natural causes among the selected trees, only 15 out of 20 trees selected in Phase I could be measured.

Figures 1 to 10 present the average number of plantules and seedlings measured within subplots for evaluation of mahogany natural regeneration in Plot 01, Plot 02 and Plot 03, established and measured in relation to mother.

These figures also present the average number of plantules and seedlings found in the 10 x 10 m subplots, in each of the three plots established for each mother tree. In each of the plots the distances considered in relation to the mother tree were 10 to 20 m; 30 to 40 m; 50 to 60 m; 70 to 80 m; 90 to 100 m; 110 to 120 m; 130 to 140 m; 150 to 160 m; 170 to 180 m and 190 to 200 m, respectively. Also, the total average number of plantules and seedlings per hectare obtained in each of the sampled trees is presented.

Phase I (Pre-harvesting): Subplot - 10 to 20 m

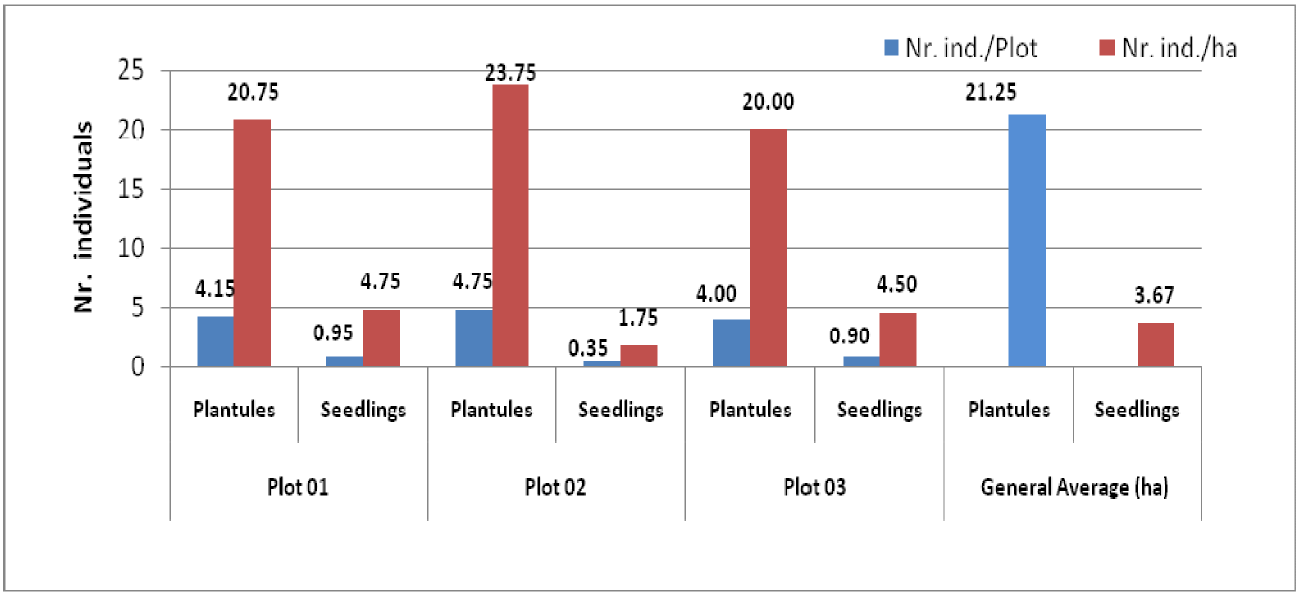


Figure 1. Average occurrence of mahogany plantules and seedlings in subplots at distance between 10 to 20 meters from mother tree.

Phase I (Pre-harvesting): Subplot - 30 to 40 m

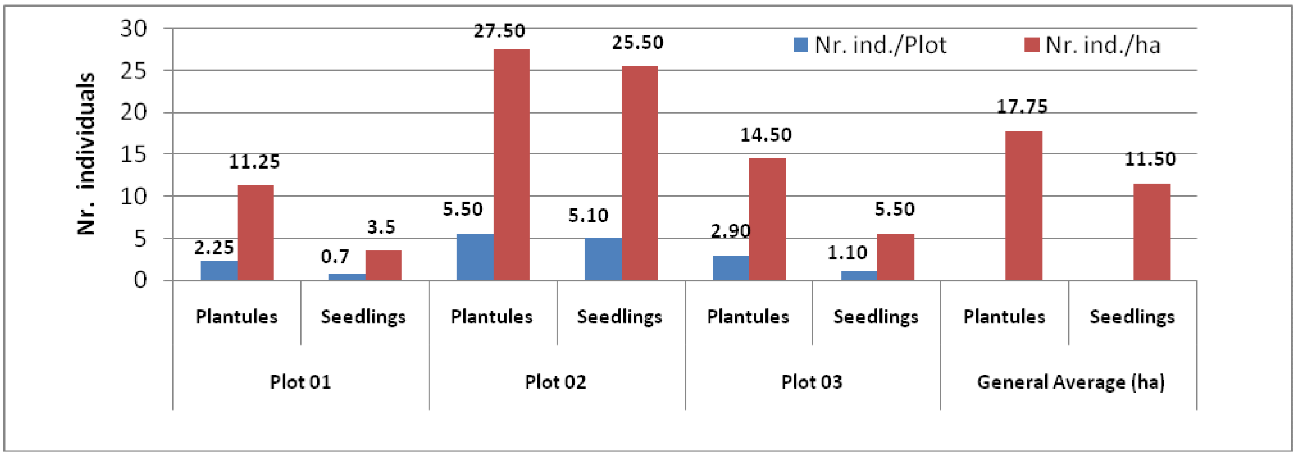


Figure 2. Average occurrence of mahogany plantules and seedlings in subplots at distance between 30 to 40 meters from mother tree.

Phase I (Pre-harvesting): Subplot - 50 to 60 m

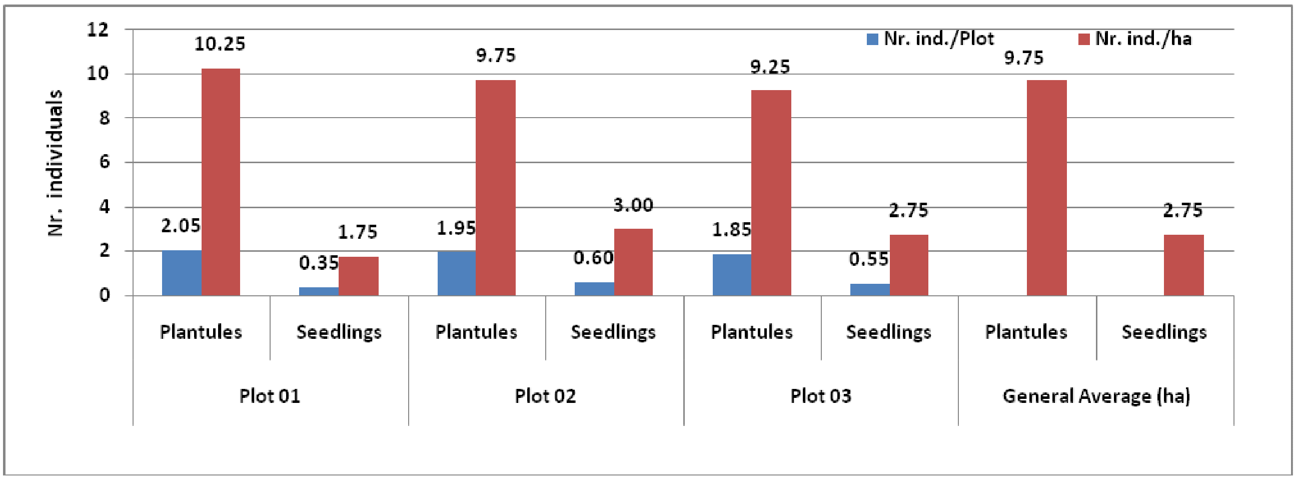


Figure 3. Average occurrence of mahogany plantules and seedlings in subplots at distance between 50 to 60 meters from mother tree.

Phase I (Pre-harvesting): Subplot - 70 to 80 m

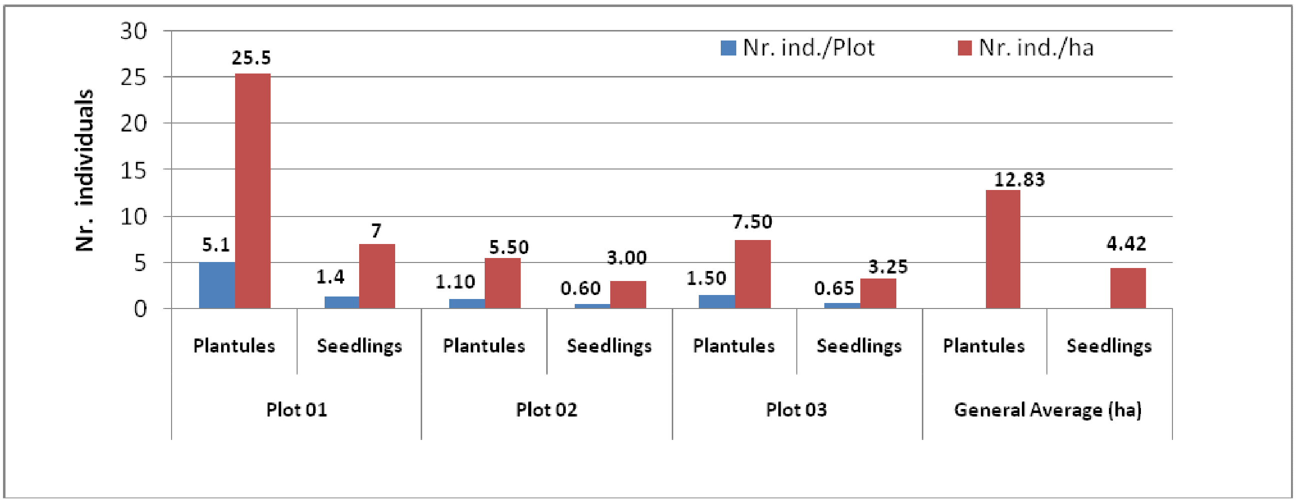


Figure 4. Average occurrence of mahogany plantules and seedlings in subplots at distance between 70 to 80 meters from mother tree.

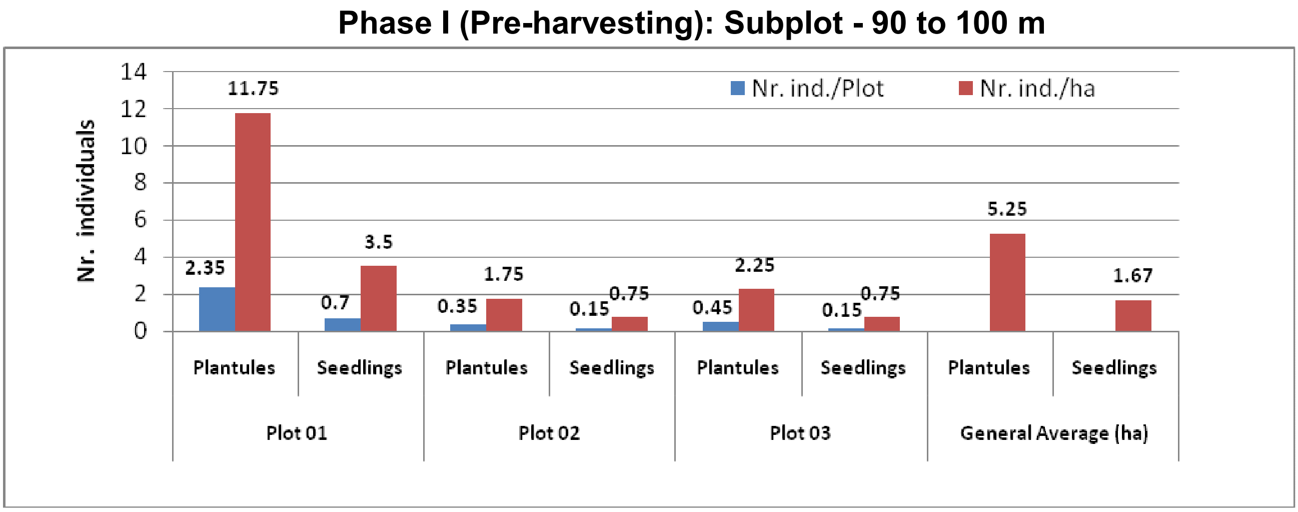


Figure 5. Average occurrence of mahogany plantules and seedlings in subplots at distance between 90 to 100 meters from mother tree.

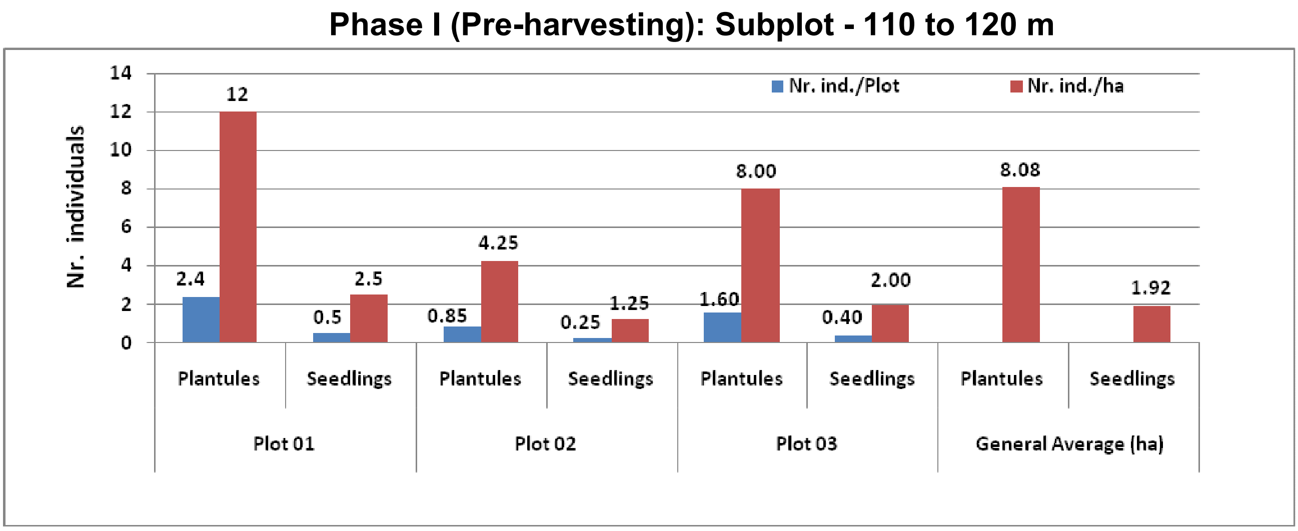


Figure 6. Average occurrence of mahogany plantules and seedlings in subplots at distance between 110 to 120 meters from mother tree.

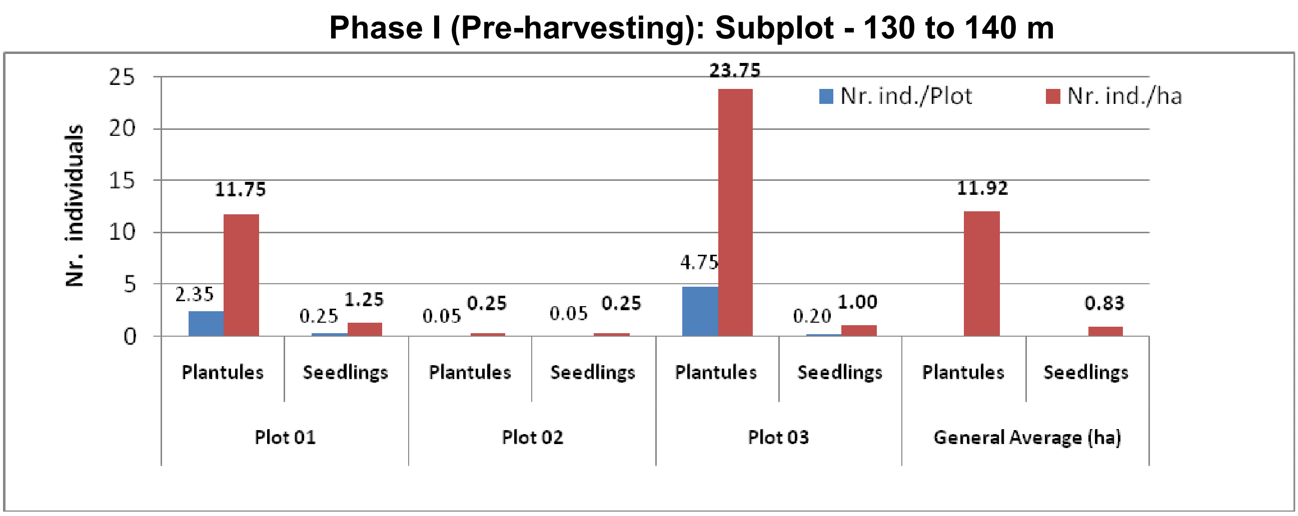


Figure 7. Average occurrence of mahogany plantules and seedlings in subplots at distance between 130 to 140 meters from mother tree.

Phase I (Pre-harvesting): Subplot - 150 to 160 m

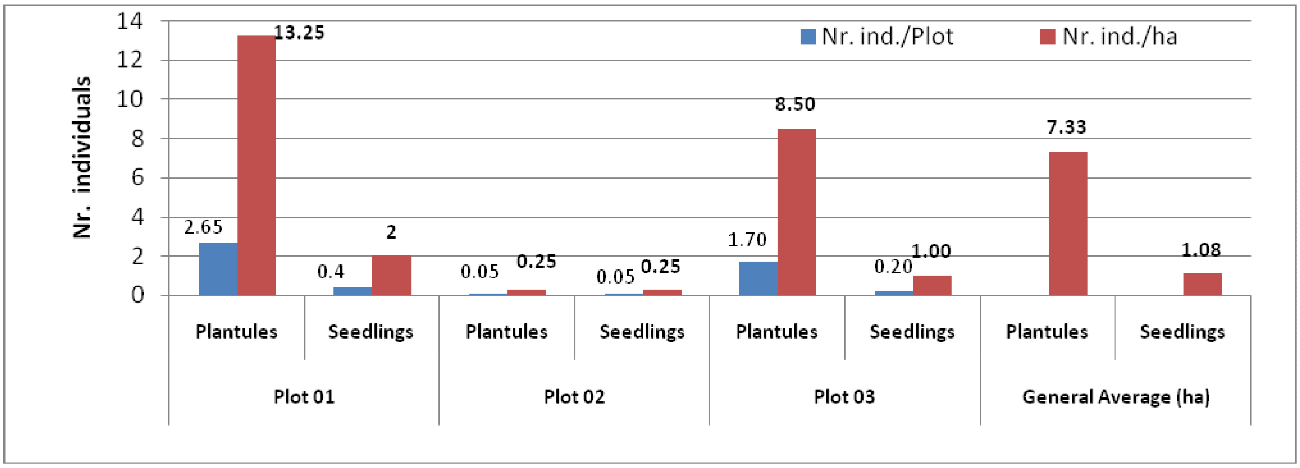


Figure 8. Average occurrence of mahogany plantules and seedlings in subplots at distance between 150 to 160 meters from mother tree.

Phase I (Pre-harvesting): Subplot - 170 to 180 m

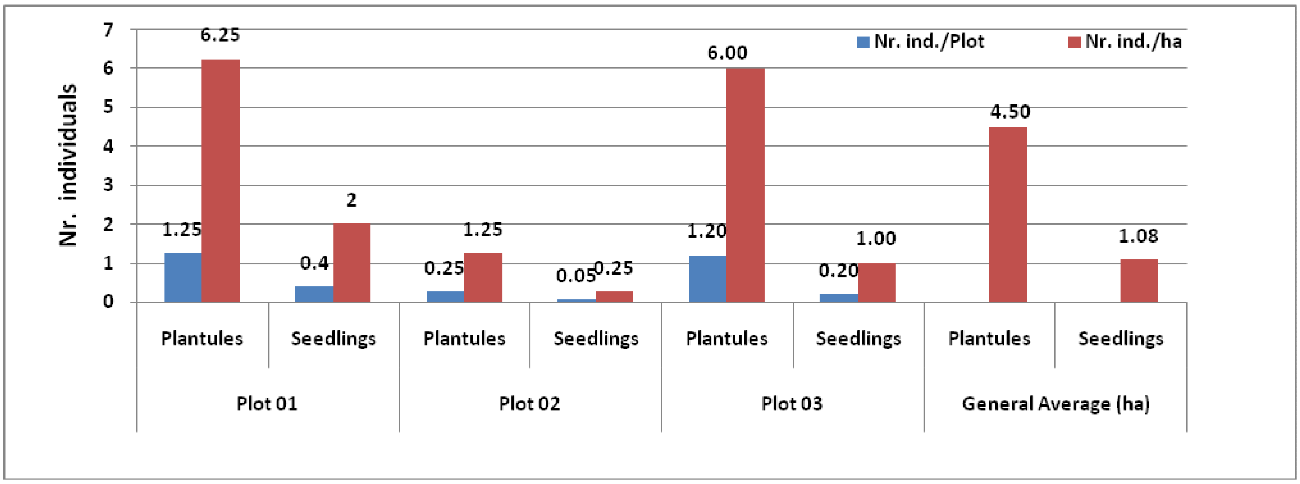


Figure 9. Average occurrence of mahogany plantules and seedlings in subplots at distance between 170 to 180 meters from mother tree.

Phase I (Pre-harvesting): Subplot - 190 to 200 m

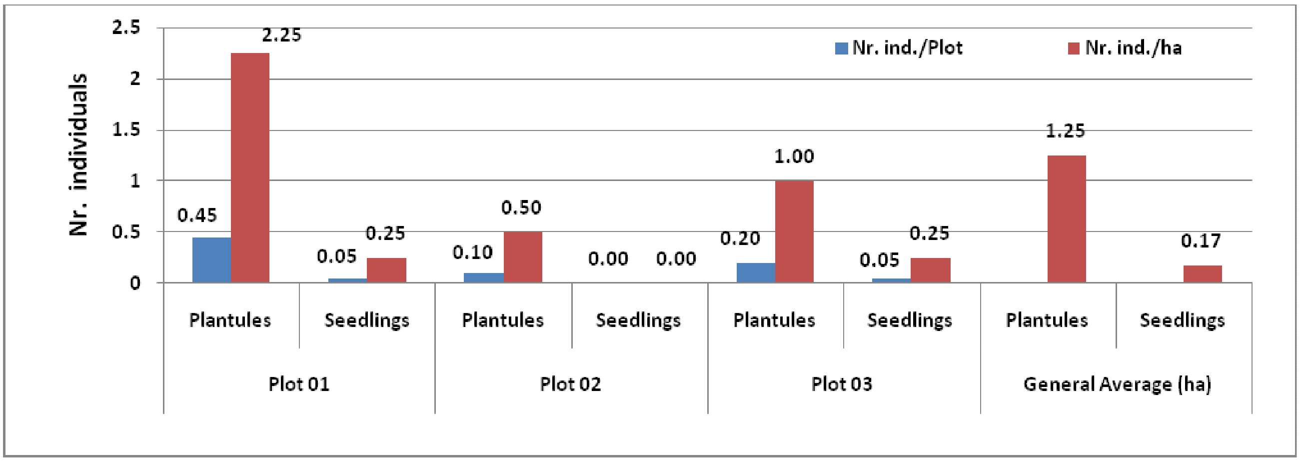


Figure 10. Average occurrence of mahogany plantules and seedlings in subplots at distance between 190 to 200 meters from mother tree.

In many subplots plantules and seedlings individuals were not registered. However, when considering the average of each particular subplot in the 20 selected mother trees, plantules and seedlings were found at all distances. This occurrence ranged on average from 1.25 ind./ha to 21.5 ind./ha for plantules and 0.17 ind./ha to 11.5 ind./ha for seedlings.

In general, the trend was the decrease of occurrence of both plantules and seedlings individuals as the subplots were more distant from mother tree, but the peak of occurrence were observed at distances of 10-20 m, 70-80 m and 130-140 m for plantules and 30-40 m and 70-80 m for seedlings.

On the other hand, despite the proposed methodology for field survey included plantules and young trees, in none of the 600 subplots inventoried mahogany of those sizes, have been observed.

The highest concentration of plantules (21.5 ind./ha) occurred in the subplots 10-20 m distant from the mother tree. At this distance also occurred the third highest concentration of seedlings per ha (3.67 ind./ha). The highest occurrence of seedlings (11.5 ind./ha) was at 30-40 m distance From this distance on, the trend of incidence of individuals decreased as the distance from the mother tree increased.

In subplots 50-60 m distant from the mother tree, the total average number of plantules per hectare registered was 9.75 ind./ha. However, for seedlings the total average was 2.50 ind./ha, showing a sharp fall of this stratum in relation to the previous subplots.

In subplots 70-80 m away from the mother tree, an increase in the number of plantules per hectare (12.83 ind./ha) occurred, as well as the record of the number of seedlings per hectare (4.42 ind./ha).

In subplots 90-100 m far from the mother tree, a decrease in the number of plantules and seedlings was verified, compared to the previous distance. This decrease was observed in more than half of the total average per hectare, representing 5.25 ind./ha for plantules and 1.67 ind./ha for seedlings.

In subplots 110-120 m far from the mother tree it was verified an increase in the number of plantules per hectare (8.08 ind./ha) in relation to the previous distance, and, a slight increase in the average number of individuals of mahogany seedlings; however this increase in the number of seedlings per hectare was small.

In subplots 130-140 m away from the mother tree, the peak in the average of plantules (11.92 ind./ha) was registered. In the seedling stratum, there was a slight decrease in its average (0.83 ind./ha). From this distance to the last distance registered (190-200 m) there was some stabilization in the total number of seedlings.

From distances 150-160 m far from the mother tree, the behavior contrary to the number of individuals of plantules per hectare was verified which decreased (7.33 ind./ha), the number of seedlings practically remained stable (0.83 ind./ha), but numbers are low up to 170-180 m.

In the last subplots the lowest number of plantules and seedlings were recorded, 1.25 ind./ha) and 0.17 ind./ha, respectively. Despite the occurrence of seedlings at this distance, the numbers were very small.

The result of occurrence of individuals of plantules and seedlings per hectare, in 20 selected trees in the study area, before harvesting, are shown in Figure 11.

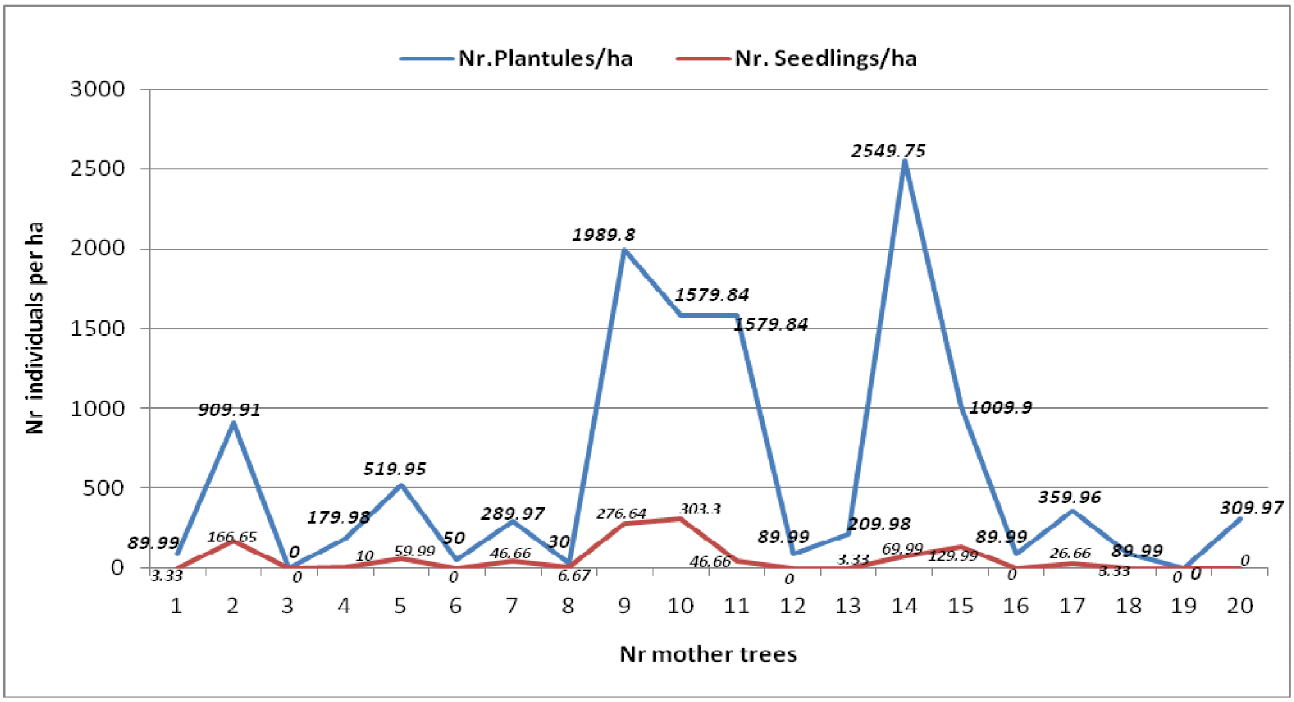


Figure 11. Occurrence of total number of plantules and seedling individuals per hectare in 20 selected mother trees for regeneration study, registered before logging.

Figure 11 shows the variation in occurrence of plantules and seedlings in the UPA-1R, object of the present study. The total number of plantules per hectare present a wide variation among 20 trees randomly selected in the population. Trees number 2, 9, 10, 11 and 14, registered high occurrence of plantules, while trees number 3 and 19 did not register any plantule.

In the seedling stratum, trees number 2, 9 and 10, as for the plantule stratum presented high occurrences of individuals. However, tree number 14 that presented the highest occurrence of plantules did not keep the same trend in the occurrence of individuals of the seedling stratum.

As mentioned earlier, although the methodology considered the measurement of the plantule stratum (2.5 cm ≤ DBH < 5.0 cm) and young tree stratum (5.0 cm ≤ DBH ≤ 9.9 cm), it has not been observed the occurrence of any individuals of these strata in 20 selected mahogany trees (60 plots) to evaluate regeneration. Bamboo vegetation of genus *Guadua* sp may have influenced mortality of plantules and seedlings, as there is a great predominance of this species in the forest as a whole, as well as in the subplots.

In areas of large canopy openings, the number of plantules registered was quite expressive. For example, tree number 14, which occurred in these conditions, presented a density of 87 plantules (2,550 plantules/ha) 130-140 m distant from its trunk.

As for seedlings, the total number in the area is far less expressive than plantules The highest concentration was in tree number 10 (303.30 seedling/ ha) followed by trees number 2, 9 and 15 which presented 276.6 seedlings/ha, 166.6 seedlings/ha and 129.9 seedlings/ha, respectively, the highest densities in the area. There were no records of seedlings in trees number 3, 6, 12, 16, 19 and 20, equivalent to 30% of sample trees.

1.2 OCCURRENCES OF PLANTULES AND SEEDLINGS DEPENDING ON THE DISTANCES FROM MOTHER TREE

In order to evaluate mahogany dissemination capacity, plantules and seedlings were recorded in subplots of 10 x 10 m at different distances from 0-200 m of each sample tree to evaluate the occurrence of mahogany individuals in different regeneration categories. Only plantules and seedlings were recorded as plantules and young trees were not found. The data are shown in Tables 1 and Table 2.

Table 1. Total number of plantules per ha within distances from 10-20 m to 190-200 m of 20 selected mahogany trees, during pre-harvesting of the area (Phase I).

PLANTULES										
	Distance (m)									
TREE	**10 – 20**	**30 – 40**	**50 – 60**	**70 – 80**	**90 - 100**	**110 - 120**	**130 - 140**	**150-160**	**170 - 180**	**190 - 200**
1	99,99	0	0	0	0	0	199,98	0	0	0
2	1333,2	966,57	99,99	0	66,66	33,33	133,32	299,97	0	99,99
3	0	0	0	0	0	0	0	0	0	0
4	199,98	66,66	66,66	33,33	0	66,66	33,33	33,33	66,66	33,33
5	266,64	333,3	366,63	33,33	0	199,98	66,66	333,3	133,32	0
6	99,99	0	66,66	0	0	0	0	0	0	0
7	366,63	299,97	133,32	33,33	33,33	33,33	33,33	33,33	0	0
8	0	0	0	0	99,99	0	0	0	0	0
9	1733,16	1066,56	333,3	1433,19	599,94	599,94	333,3	133,32	233,31	166,65
10	1733,16	1599,84	699,93	366,63	533,28	199,98	0	399,96	33,33	0
11	433,29	1133,22	633,27	1933,14	233,31	33,33	433,29	299,97	99,99	33,33
12	33,33	0	0	133,32	0	66,66	0	66,66	0	0
13	0	133,32	33,33	33,33	0	99,99	0	199,98	166,65	33,33
14	899,91	833,25	399,96	366,63	299,97	1133,22	2899,71	766,59	766,59	133,32
15	599,94	566,61	633,27	466,62	199,98	499,95	266,64	99,99	33,33	0
16	166,65	66,66	66,66	0	0	0	0	0	0	0
17	133,32	33,33	166,65	66,66	0	133,32	366,63	199,98	99,99	0

18	66,66	0	99,99	0	0	133,32	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0
20	433,29	0	99,99	233,31	33,33	0	0	66,66	166,65	0

Table 2. Total number of seedlings per ha within distances from 10-20 m to 190-200 m of 20 selected mahogany trees, during pre-harvesting of the area (Phase I).

SEEDLINGS										
Distance (m)										
TREE #	**10-20**	**30-40**	**50-60**	**70-80**	**90 -100**	**110 - 120**	**130 - 140**	**150- 160**	**170 - 180**	**190 - 200**
1	**0**	**0**	**0**	**0**	**0**	**0**	**33,33**	**0**	**0**	**0**
2	**433,29**	**866,58**	**33,33**		**33,33**	**0**	**0**	**33,33**	**33,33**	**33,33**
3	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
4	**0**	**66,66**	**0**	**0**	**0**	**33,33**	**0**	**0**	**0**	**0**
5	**366,63**	**133,32**	**0**	**66,66**	**0**	**0**	**0**	**33,33**	**0**	**0**
6	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
7	**0**	**266,64**	**33,33**	**99,99**	**66,66**	**0**	**0**	**0**	**0**	**0**
8	**0**	**0**	**0**	**33,33**	**33,33**	**0**	**0**	**0**	**0**	**0**
9	**233,31**	**799,92**	**133,3**	**733,2**	**333,3**	**299,97**	**99,99**	**0**	**99,99**	**33,33**
10	**266,64**	**1633,17**	**199,9**	**333,3**	**66,66**	**66,66**	**99,99**	**166,65**	**199,98**	**0**
11	**33,33**	**99,99**	**33,33**	**199,9**	**33,33**	**33,33**	**0**	**33,33**	**0**	**0**
12	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
13	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**33,33**	**0**
14	**33,33**	**233,31**	**233,3**	**33,33**	**0**	**66,66**	**33,33**	**66,66**	**0**	**0**
15	**99,99**	**433,29**	**333,3**	**66,66**	**33,33**	**199,98**	**33,33**	**99,99**	**0**	**0**
16	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
17	**0**	**33,33**	**0**	**0**	**66,66**	**66,66**	**33,33**	**0**	**66,66**	**0**
18	**0**	**33,33**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
19	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
20	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

Table 2 shows the densities of mahogany seedlings in 20 sample trees according to the distance from base of the tree.

Although in some trees there has not been occurred, in most of remaining trees mahogany plantules were recorded at distances ranging from 160 to 200 m. Thus, the result shows that plantules individuals are distributed to a radius of 145 meters on average, from the trunk of the mother tree.

For the seedling stratum, the number of trees with zero occurrence corresponded to 30%, although it has occurred up to a distance 200 meters; as occurred with mother tree number 2, the seedlings on average have been distributed to 104 meters away from the trunk of mother tree (Figure 12).

The results corroborate Gullison et al. (1996) who pointed out that mahogany requires high amount of sunlight and canopy openings in the forest to establish. Therefore this explains the absence of plantules and seedlings in the subplots related to the trees mentioned earlier in the present research.

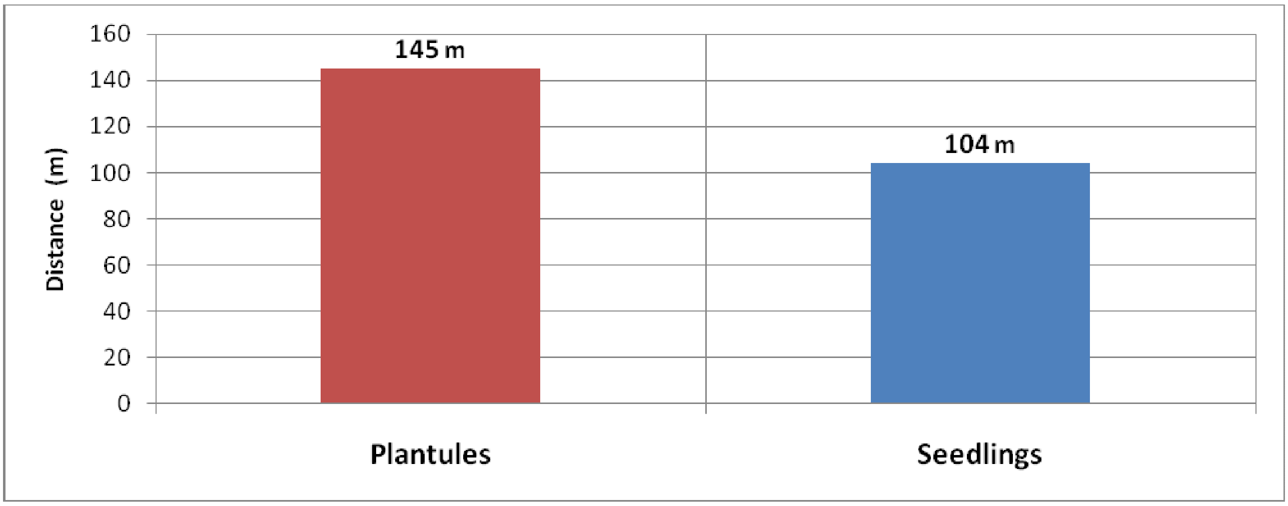


Figure 12. Average distance in meters of occurrence of individuals of plantules and seedlings strata in relation to the trunk of mother tree in pre-harvesting phase.

The variation and trend of occurrence considering the distances are shown in Figure 13.

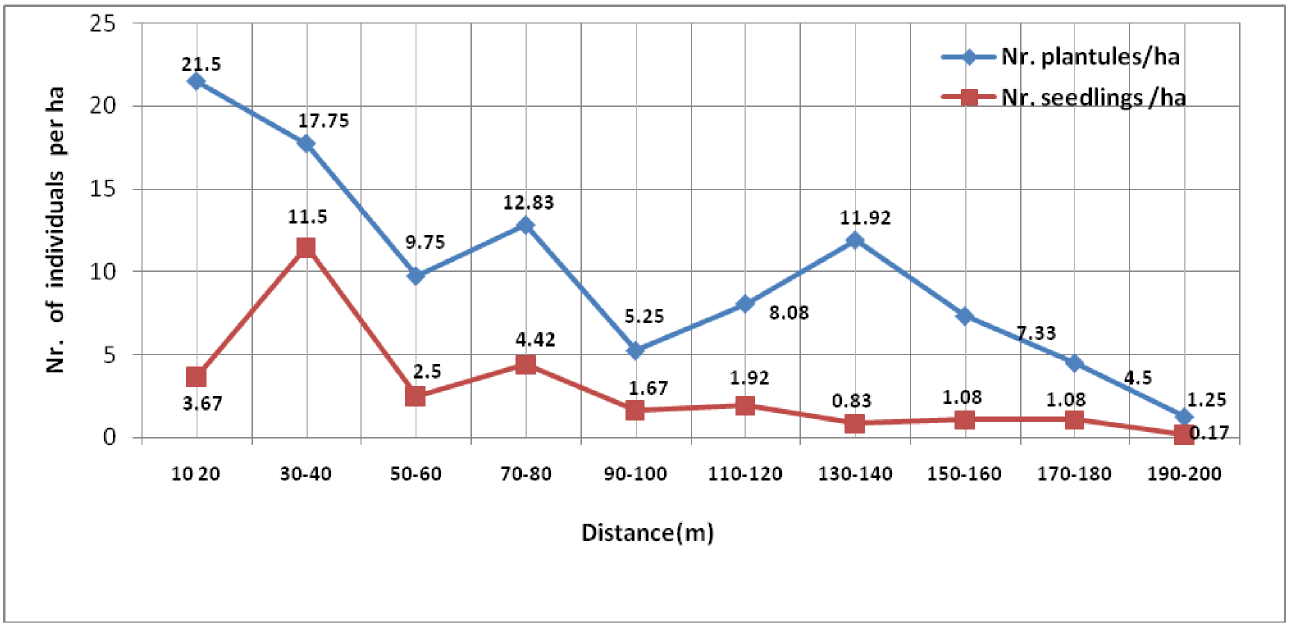


Figure 13. Average number of plantules and seedlings individuals per hectare at a distance from 10-20 m to 190-200 m.

Figure 13 presents the amount of plantules and seedlings per hectare that occurred in the mahogany regeneration plots within 200 m from the mother tree. As mentioned earlier, both plantules and seedlings occur in all studied distances. The number of plantules (ind./ha) is higher in all distances compared to seedlings, but for both categories, the number of individuals decreases as the distance from the mother tree increases.

2. GENERAL DATA OF HARVESTING

Harvesting of the UPA-1R resulted in a volume of 10,483 m^3 from 1,275 trees (~0.9 trees per ha) and 3,912 logs of commercial species, giving an average of 8.223 m^3 per tree and 2.68 m^3 per log harvested.

The total area opened for constructing the logging infrastructure was nearly 30 ha or 2% of the net area of the annual coupe. The total opened area was divided into 2.52 ha of access roads (2.8 km), 21.75 ha of secondary roads (43.5 km), and 5,7 ha of logging decks (114 logging decks of 20X25 m - 500 m^2 each.

Figure 14. (A and B) Access roads within the UPA-1R area used by logging activities with occurrence of shaded areas; (C) Part of access road completely closed by bamboo.

Out of 110 mahogany) trees, inventoried in the annual coupe, 45 trees were selected for harvesting after applying all restrictions established by the forest management regulations. However, only 30 trees were actually harvested due to hollow stems and rot (Figure 15).

Figure 15. (A) Opening of felling notch of a mahogany tree harvesting in the UPA-1R area; (B) Worker running in an escape route during mahogany tree felling; (C) Mahogany tree roots after felling; (D) Measurement for conversion of log (tree stem) to sawnwood.

Thus, the total volume of mahogany harvested in the UPA-1R area was 538.212 m³, or 17.94 m³ per tree. In addition to the volumes of stems, the volume of large branches comprised about 40% of the stem volume harvested.

3. FOREST INVENTORY OF NATURAL REGENERATION OF *SWIETENIA MACROPHYLLA* KING (MAHOGANY), AFTER HARVESTING OF THE STUDYAREA.

3.1 Occurrences of Plantules and Seedlings at Different Distances from the Mother Tree.

Figures 16 to 25 present the average number of plantules and seedlings measured within subplots of mahogany natural regeneration in Plot 01, Plot 02 and Plot 03 established and measured in relation to mother tree.

Phase II (Post-Harvesting): 10-20 m from mother tree

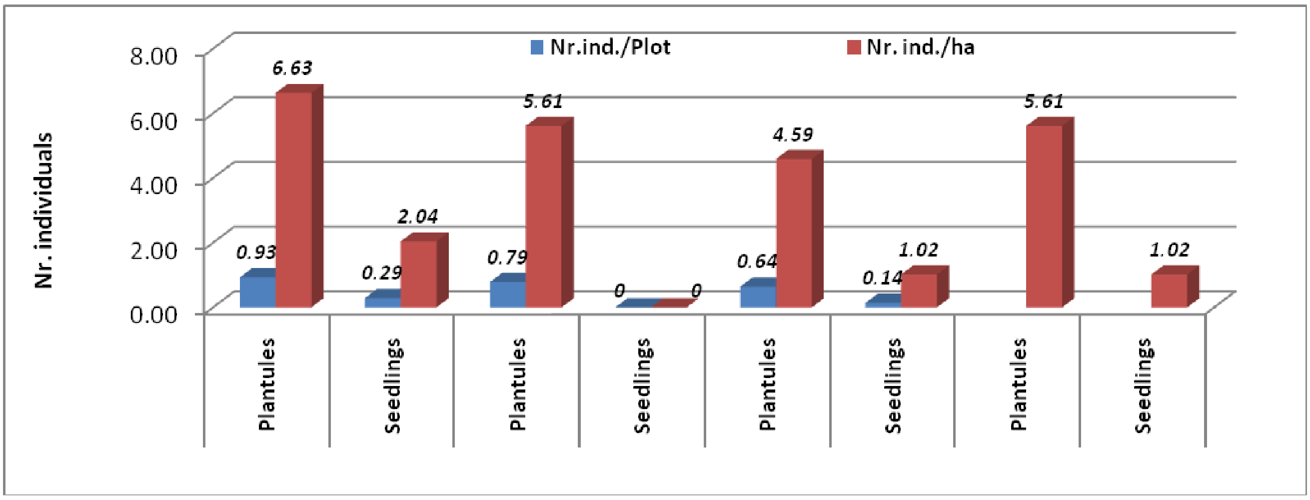


Figure 16. Number of plantules and seedlings within subplots at distances of 10-20 m from mother tree.

Phase II (Post-Harvesting): 30 – 40 m from mother tree

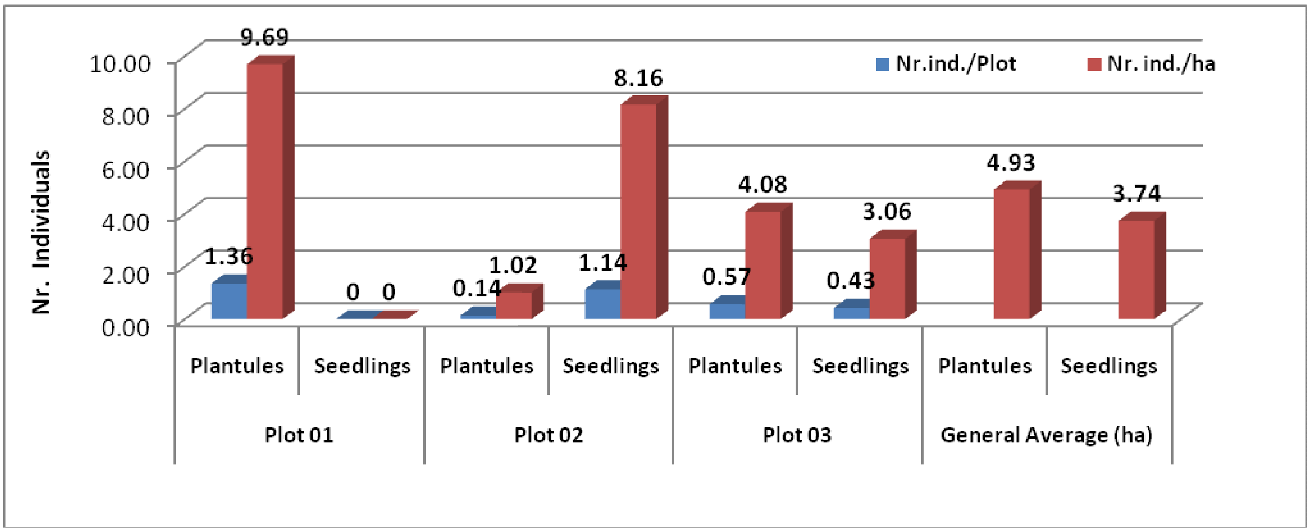


Figure 17. Number of plantules and seedlings within subplots at distances of 30-40 m from mother tree.

Phase II (Post-Harvesting): 50 – 60 m from mother tree

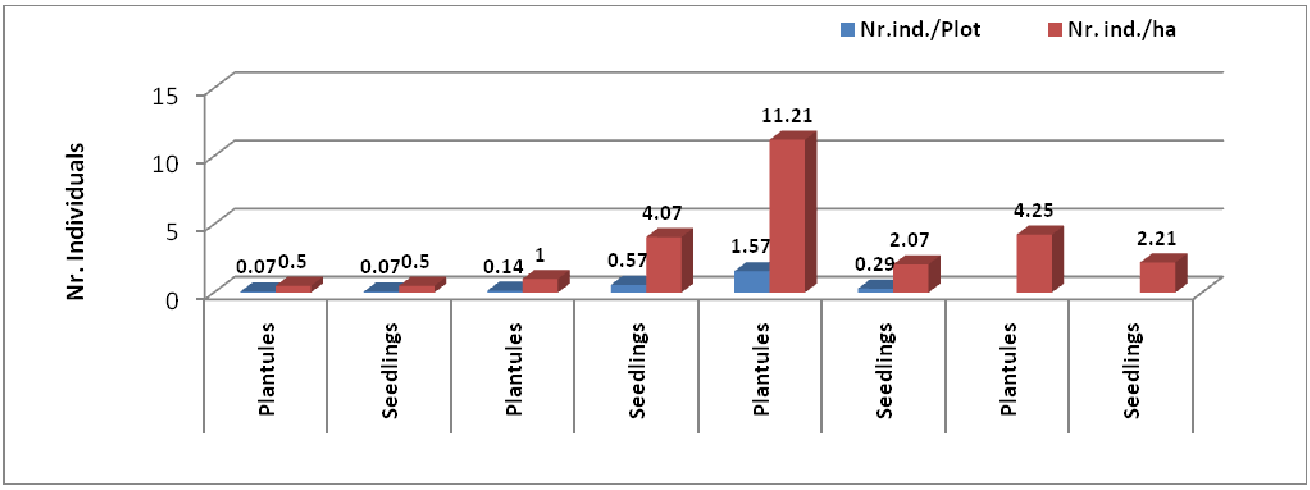


Figure 18. Number of plantules and seedlings within subplots at distances of 50-60 m from mother tree.

Phase II (Post-Harvesting): 70 – 80 m from mother tree

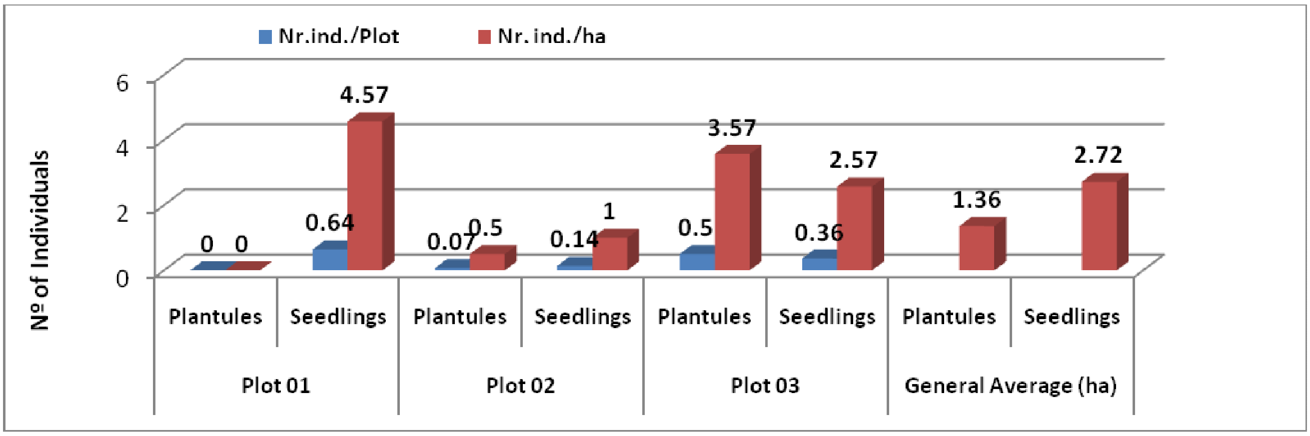


Figure 19. Number of plantules and seedlings within subplots at distances of 70-80 m from mother tree.

Phase II (Post-Harvesting): 90 – 100 m from mother tree

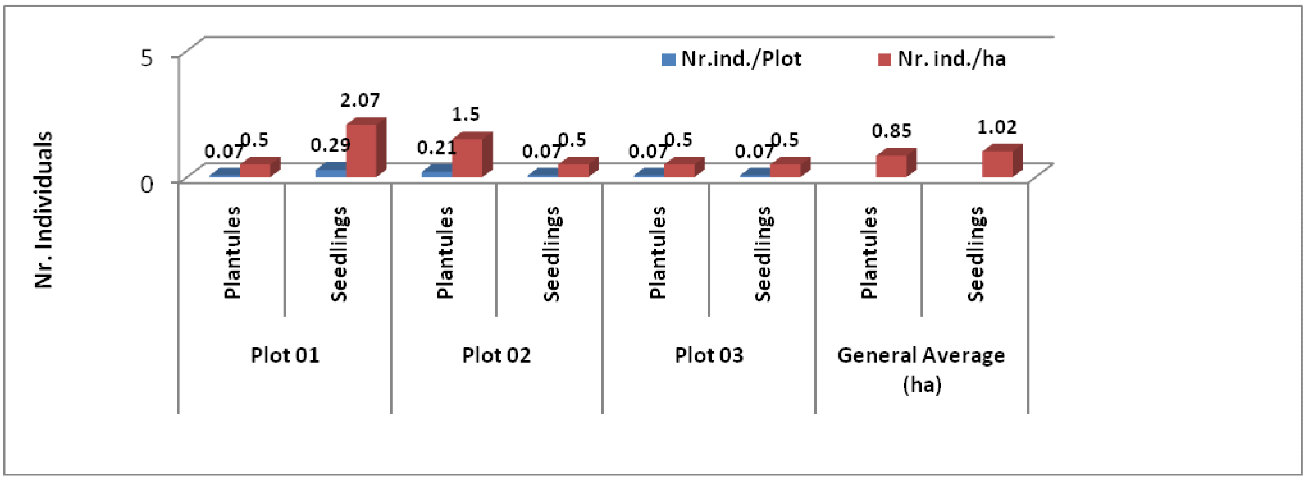


Figure 20. Number of plantules and seedlings within subplots at distances of 90-100 from mother tree.

Phase II (Post-Harvesting): 110 – 120 m from mother tree

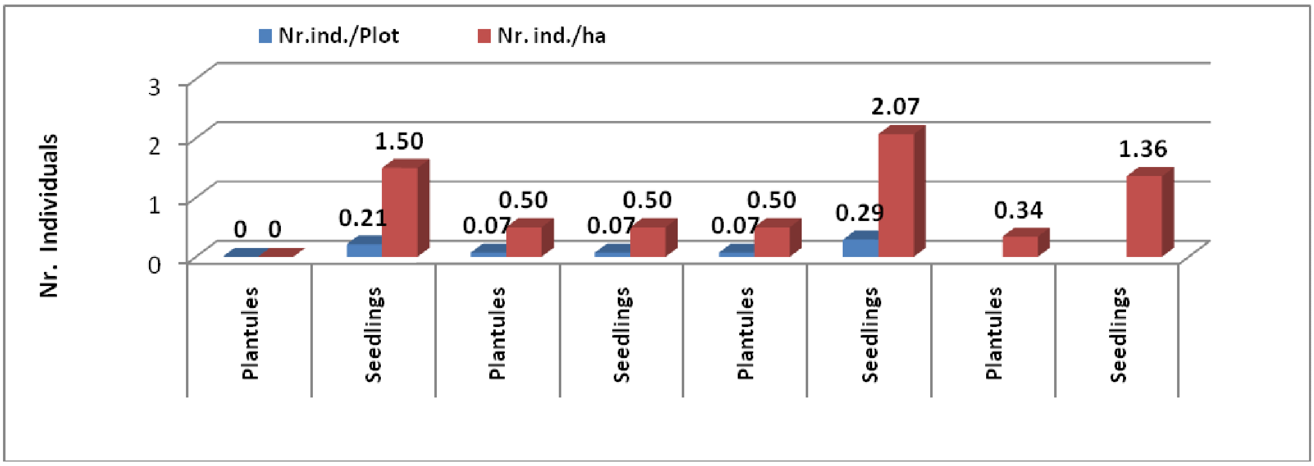


Figure 21. Number of plantules and seedlings within subplots at distances of 110-120 m from mother tree.

Post-Harvesting Phase: 130 – 140 m from mother tree

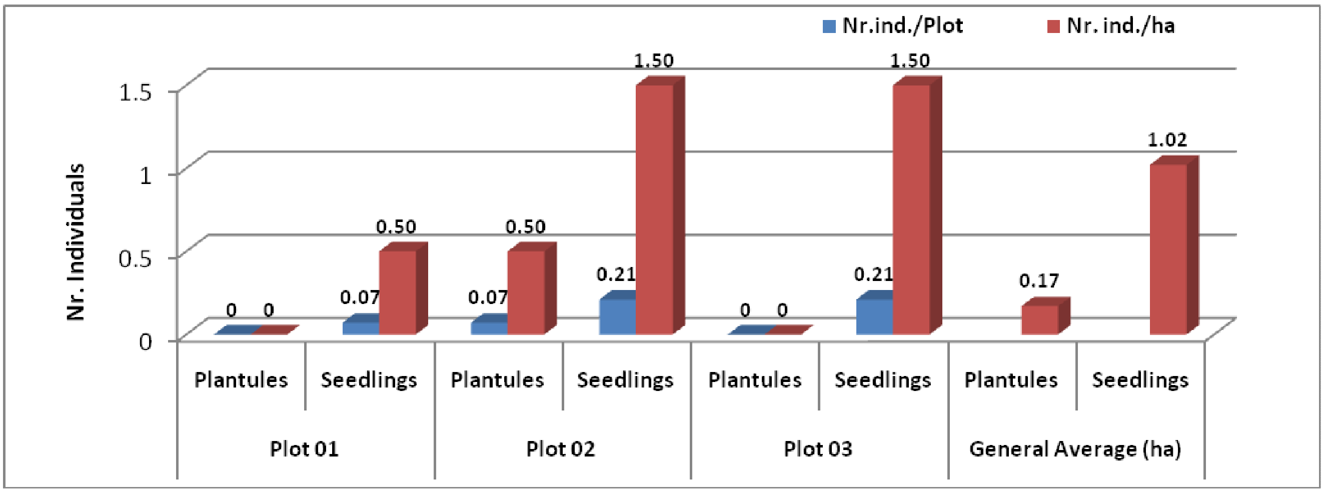


Figure 22. Number of plantules and seedlings within subplots at distances of 130-140 m from mother tree.

Phase II (Post-Harvesting): 150 – 160 m from mother tree

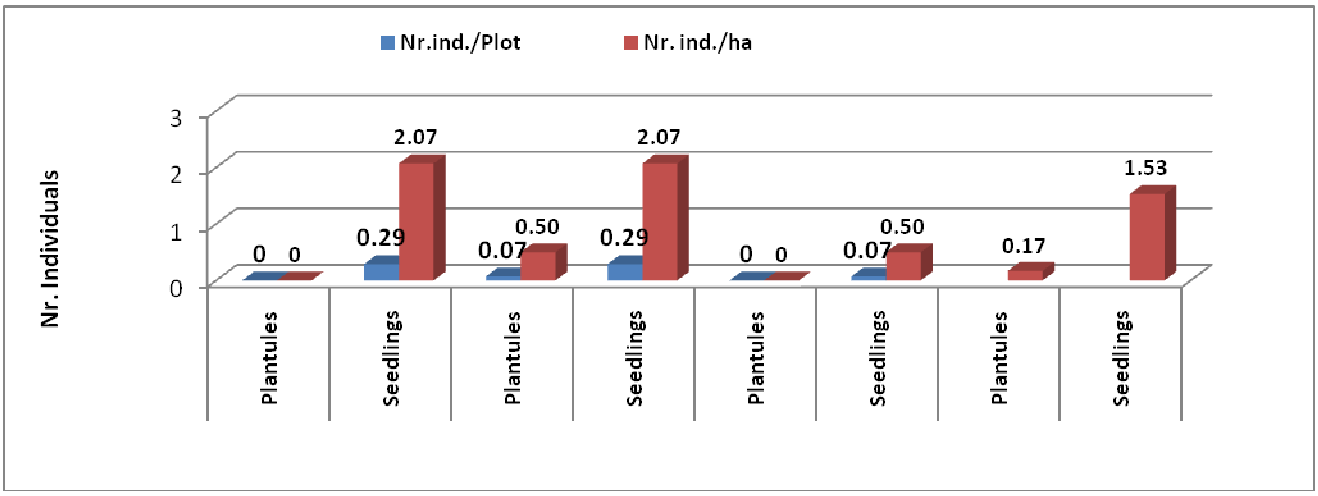


Figure 23. Number of plantules and seedlings within subplots at distances of 150-160 m from mother tree.

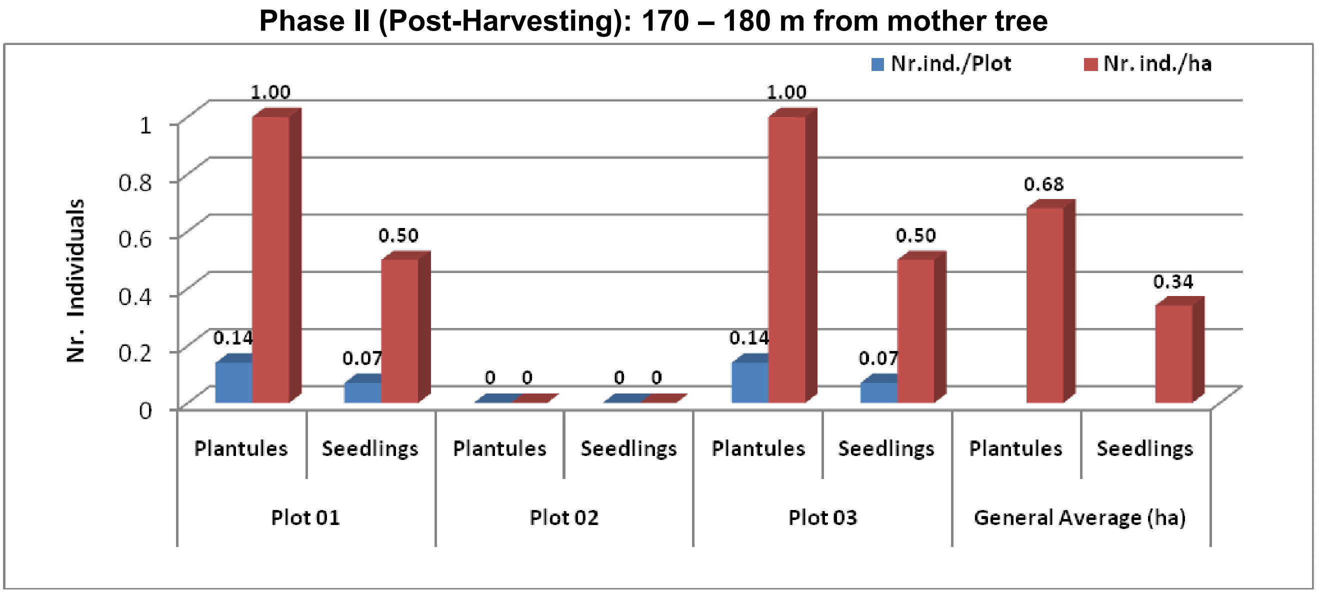


Figure 24. Number of plantules and seedlings within subplots at distances of 170-180 m from mother tree.

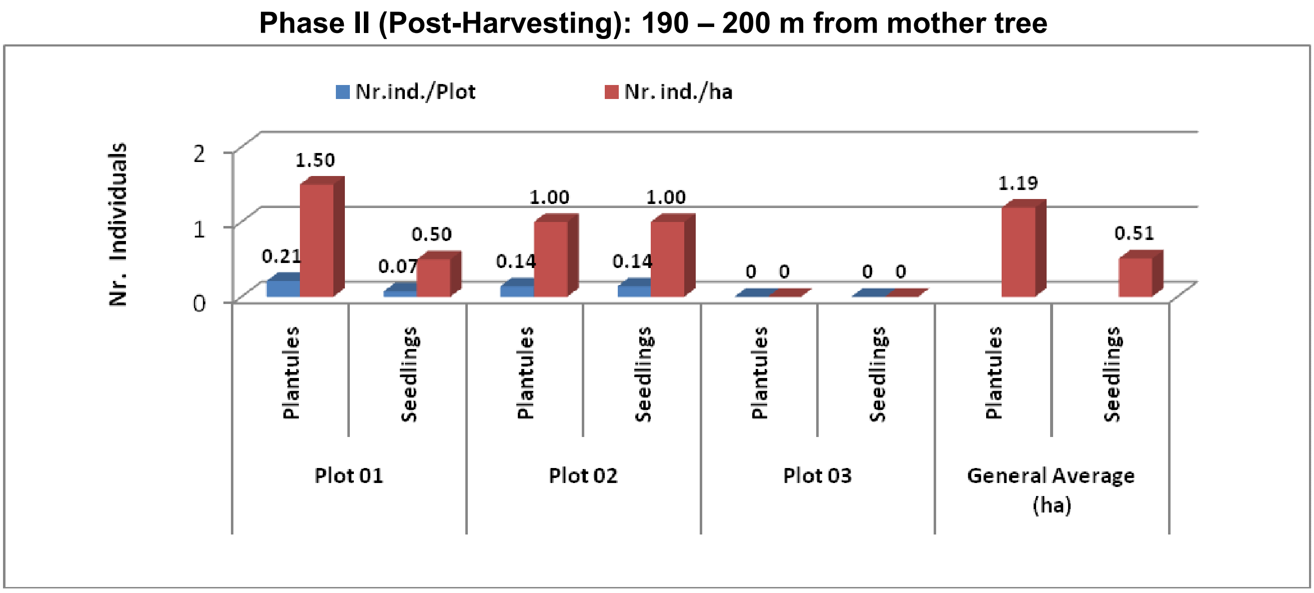


Figure 25. Number of plantules and seedlings within subplots at distances of 190-200 m from mother tree.

The field survey in Phase II (Post-harvesting), took place immediately after the end of logging activities. Thus, the results obtained, do not reflect the effect of canopy opening on growth and recruitment of plantules and seedlings in the area.

On the other hand, the hypothesis that the plantules and seedlings, found in established plots, come from a single mother tree, is difficult to verify, considering the other seed bearers located in the area, even if they are far away.

Although in two selected mother trees no plantules have not occurred, in most of the remaining trees they have been found at distances ranging from 20 to 140 m. Thus, the results shows that on average, plantules are distributed to a 61 meters radius of the mother tree.

The number of trees with zero occurrence of seedlings corresponded to 10%; although occurrence has been verified up to a distance of 200 meters of the mother tree., The seedlings were distributed on average to 123 meters away from the trunk of the mother tree. (Figure 26).

As shown in Figure 12, the average distances of plantules and seedlings occurrence in the post-harvesting phase were, respectively, 145 m and to 104 m. The impacts of harvesting reduced to 61 m for plantules, whereas for seedlings the distance increased to 123 m.

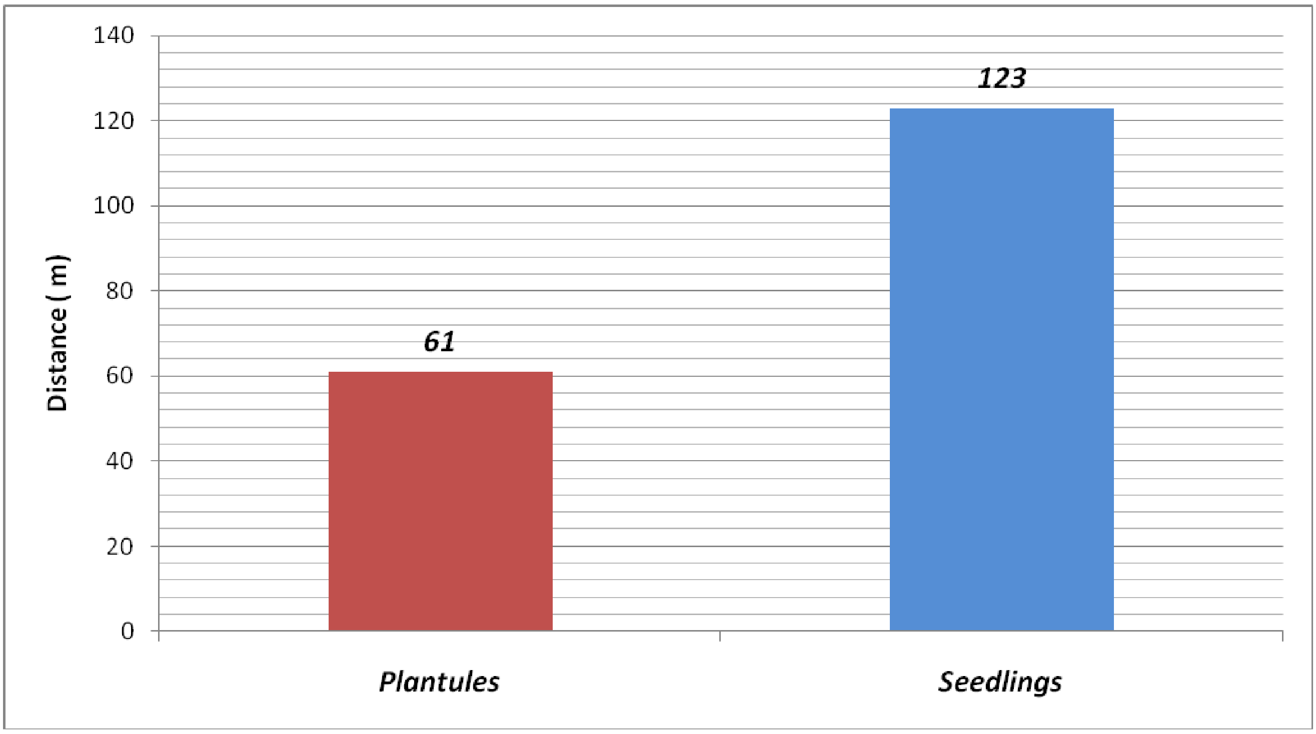


Figure 26. Average distance in meters of occurrence of plantule and seedling strata individuals in relation to the trunk of mother tree in post-harvesting phase (Phase II).

Grogan and Galvão (2006a), in a logged area of the Fazenda Marajoara, located in the Southeast region of Pará State, in Brazil, observed that in the dry season the dominant winds dispersed most of mahogany seeds in the western-northwest direction, reaching distances of approximately 100 m. Most of the seed falls in a radius of 35 m on the West side, ranging from 9 to 28 meters on East and West sides, respectively, and 100% of seeds fell within an area slightly smaller than one hectare (0.91 ha).

Comparing the findings of the present study with those reported by Grogan and Galvão (2006a) in the Eastern Amazon, it was observed that the seed dispersal distance is at least double (61 m) for plantules and 4 times more (123 m) for seedling occurrence in the Western Amazon where this research was carried out.

Figure 27 shows that the occurrence of plantules and seedlings decrease as distance increases from mother tree. The number of plantules ranged from 5.61 ind./ha within the distance between 10-20 m to 1.36 ind./ha on 70-80 m distant from the mother tree., From that distance on, a strong decrease was registered (0.17 ind./ha) within 150-160 m from the mother tree, and an increase at the distance 190-200 m where 1.19 ind./ha were registered.

As to seedlings, the occurrence remained relatively stable from 10-20 m to 150-160 m., It was observed a considerable decrease of 0.34 and 0.51 ind./ha, within the distance from 170-180 m to 190-200 m respectively. The peak of occurrence was 3.74 ind./ha 30-40 m distant from the mother tree.

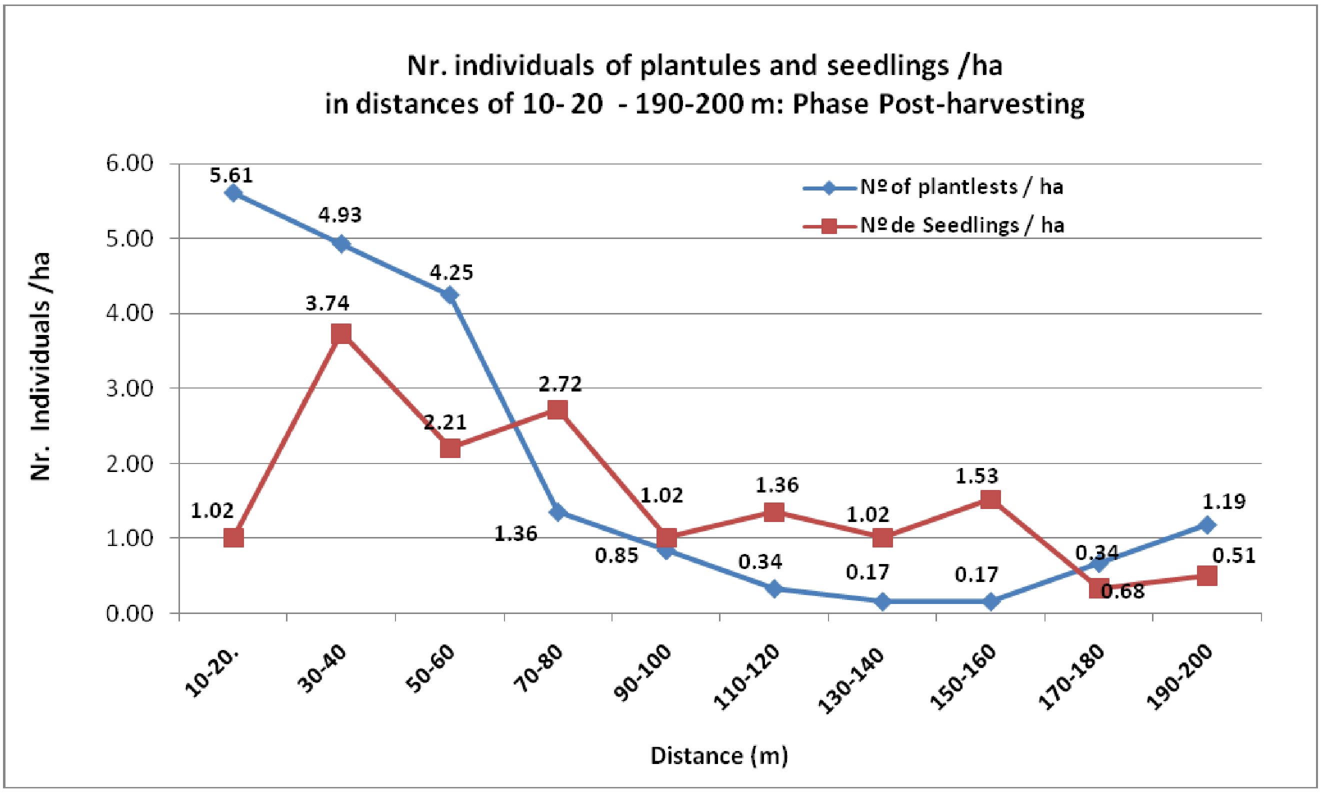


Figure 27. Comparison of number of plantules and seedling individuals per hectare considering distances in relation to mother tree in post-harvesting phase.

3.2 STOCKS OF PLANTULES AND SEEDLINGS IN PRE AND POST-HARVESTING PHASES

As mentioned earlier, the data of plantules and seedlings collected in the post-harvesting phase, do not reflect the disturbances caused by logging activities that took place in the area, especially the canopy openings due to tree felling, as well as, the openings from construction of roads and log decks. However, it is possible to observe the effects of logging activities impacts on plantules densities before and after harvesting (Figure 28).

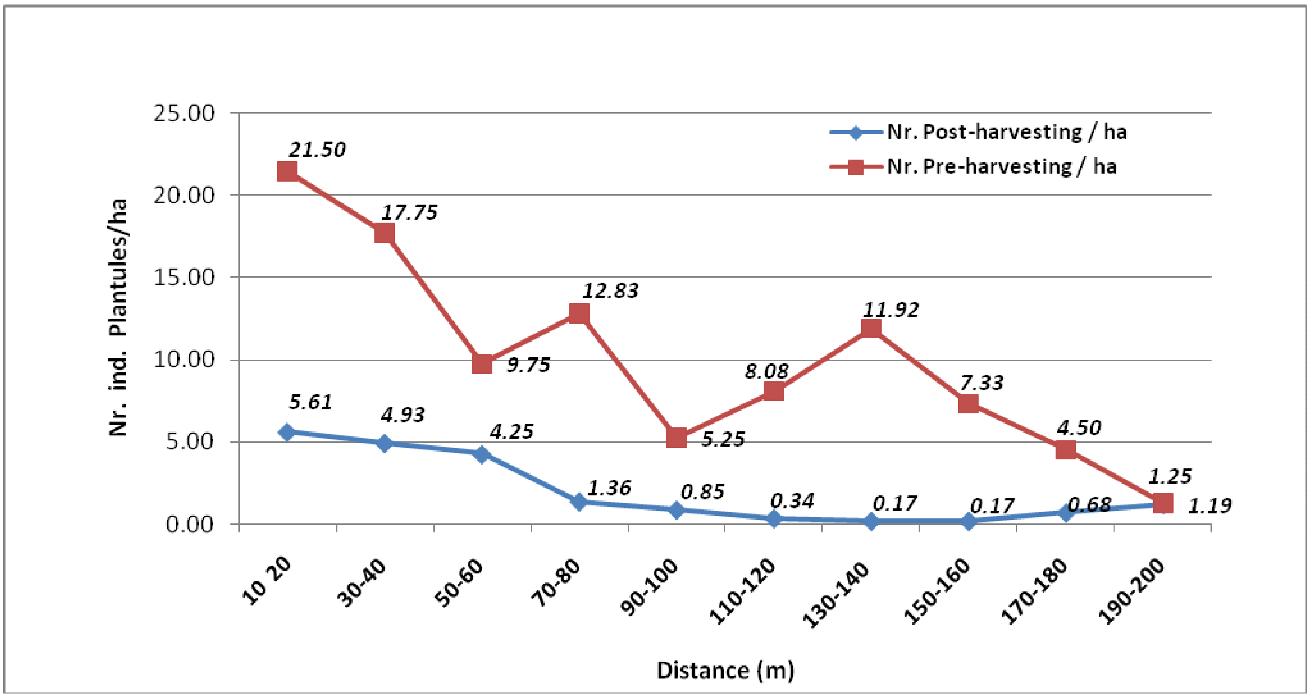


Figure 28. Comparison of number of plantules per hectare considering distances in relation to mother tree in pre- and post-harvesting phases.

Figure 28 shows that on average the number of plantules occurs at all distances up to 190-200 m, both in pre-harvesting and post-harvesting phases. However, before harvesting, the density of plantules at different distances observed are all higher than the density at the same distances, when surveyed in the Phase II, post-harvesting.

Mahogany (*Swietenia macrophylla* King), is a long lived intolerant i.e. its seeds can germinate under shade, but can only grow and establish if an event of forest canopy opening occurs. Results of the present research show that there was a significant decrease in density of mahogany plantules shortly after logging activities. In principle, this decrease may have been caused by the impact of logging, which uses heavy machinery resulting in the increase in catastrophic mortality.

Another possible factor that may explain the high mortality just after canopy opening by logging is the attack of caterpillars (*Steniscadia poliophaea*) that usually destroy the leaves of the plantules. According to Grogan et al. (2005a), 90% of recently germinated plantules die due to attacks of caterpillars. The attack decreases as the distance from the mother tree increases. However, the occurrence of this pest in the study area was very small.

Barros et al. (1992) state that fruits, seeds, plantules and seedlings of mahogany suffer dirferent forms of predation, such as pest attacks such as the microlepdoptera *Hypsipyla grandella* Zeller, that often attacks the fruit yet in crowns of adult trees and on the forest floor. In seedlings and small trees, the mahogany shoot borer attacks the apex of the plant frequently leading to death; in other cases the seedlings survive with constant re-sproutings, but leaving stems often damaged with low economic value. For this reason, *Hypsipyla grandella,* Zeller is considered the main plague of mahogany species. Another limiting factor for mahogany plantules and seedlings survival is the fact that in this study area, as mentioned before, the bamboo (*Guadua* sp) occurs at heavy densities in the area, quickly covering the forest understorey, and thus preventing natural regeneration of the species.

Norghauer et al. (2010) report for the Southeastern Amazon, that the heaviest attack intensity, leaf area loss and mortality of plantules occurred in individuals located nearby the mother tree.

Considering the density of plantules before and after harvesting, the impact of logging occurred at all distances in relation to mother tree, causing a high mortality rate, ranging from 72.2% to 98.6% in most distances from the mother tree, excep for 50-60 m and 190-200 m distances, which presented lower mortality (56.4% and 4.8%), respectively., The average mortality of plantules was 75.7% between the pre and post-harvesting phases. (Figure 29).

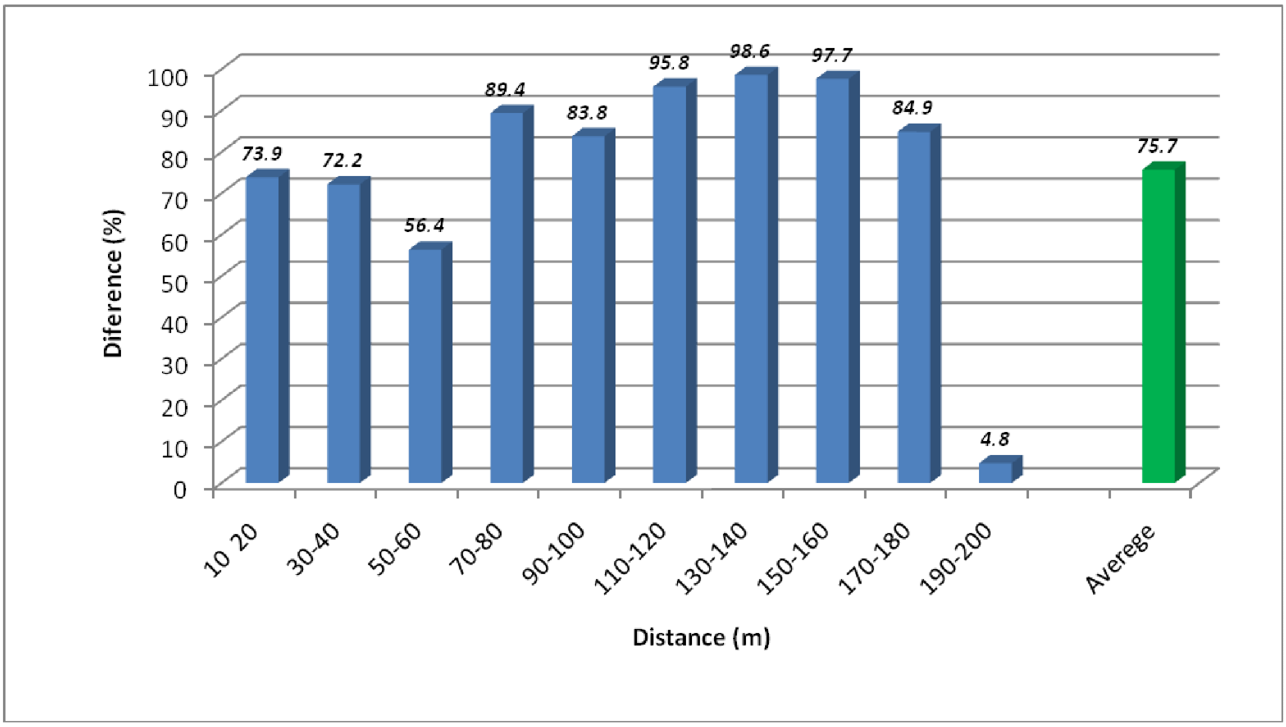


Figure 29. Reduction in plantules densities considering the impacts of logging in the area, by distance and total average.

Grogan, et al. (2005a) studied the dynamics of mahogany regeneration the southeastern Pará state, Brazil, monitoring naturally established plantules in the forest understory and in canopy openings in order to verify whether mahogany plantules could survive and respond to canopy opening after a period of suppression by the understory vegetation.

In the forest understory, the authors found that after 8 years monitoring only 1 to 2% of plantules had survived. It was also verified that within the monitoring period, the average growth of plantules in height was very low, approximately 4 $cm.year^{-1}$, confirming that *Swietenia macrophylla*, King, despite not being a pioneer species is extremely light demanding.

Regarding the survival and growth of seedlings in experimental canopy openings, Grogan, et al. (2005a) monitored during 80 months and found that a greater plantules mortality occurred during the first dry season after canopy opening (treefall gap), and presented low mortality rates in other monitoring periods. Therefore plantules demonstrated ability to react to the subsequent canopy release. As to the average height growth, the of plantules in treefall gaps it ranged from 23.9 cm to 126.1 cm. $year^{-1}$.

On the other hand, Grogan and Galvão (2006a) also reports that the density of mahogany (*Swietenia macrophylla* King) plantules, generally is low or non-existent, soon after logging. For the authors several factors may limit the density just after harvesting such as production of seeds, germinating power, seed dispersion patterns, and concluded that the plantules find more favourable survival conditions in treefall gaps, and therefore at high densities only in cases in which the fruit production rates previous to logging were high (4 to 12.5%) per year, and where the trees were felled to West or Northwest direction.

Regarding the behavior of seedlings density before and after harvesting, Figure 30 shows that although the density is lower than the density of plantules. In general it shows the same trend as what has been observed for plantules, but at the distance up to 50-60 m, the logging impacts in the reduction of density were more evident. From that distance onwards, damage was lower.

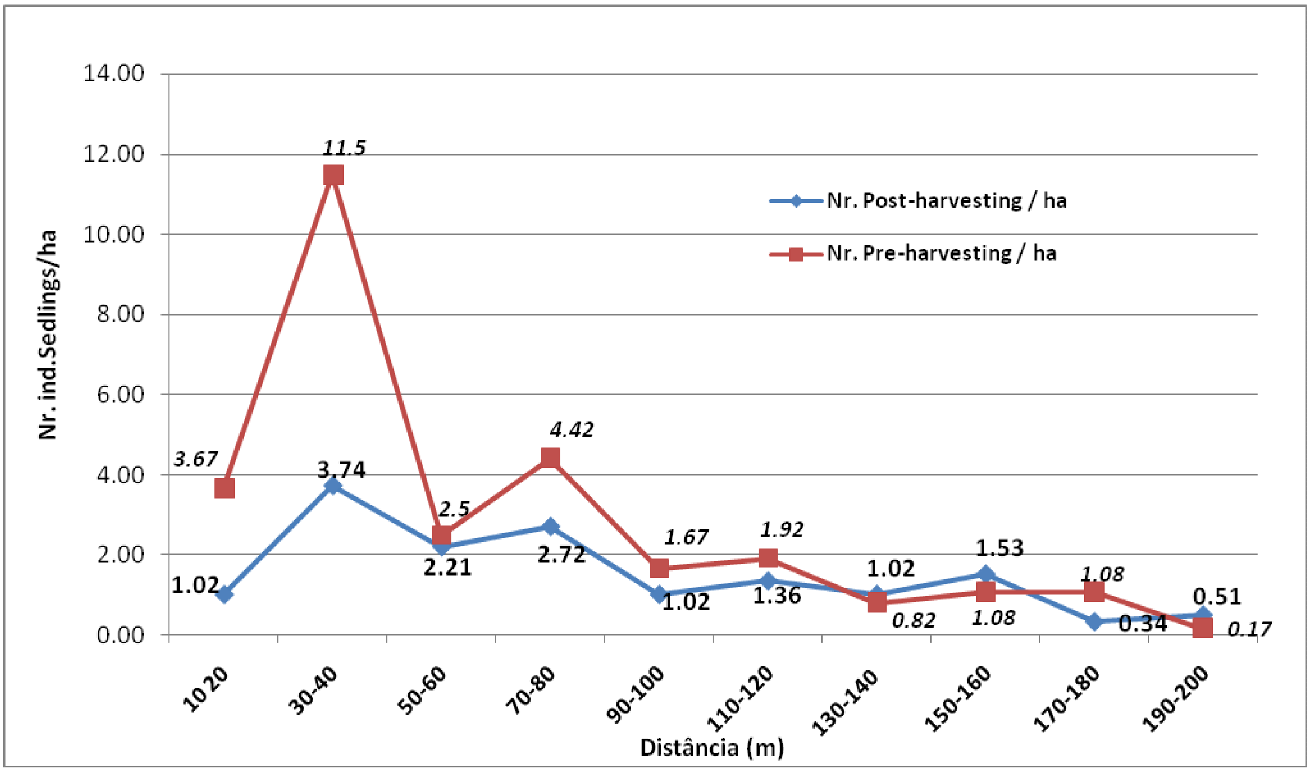


Figure 30. Comparison of number of seedling individuals per hectare considering distances in relation to mother tree in pre- and post-harvesting phases

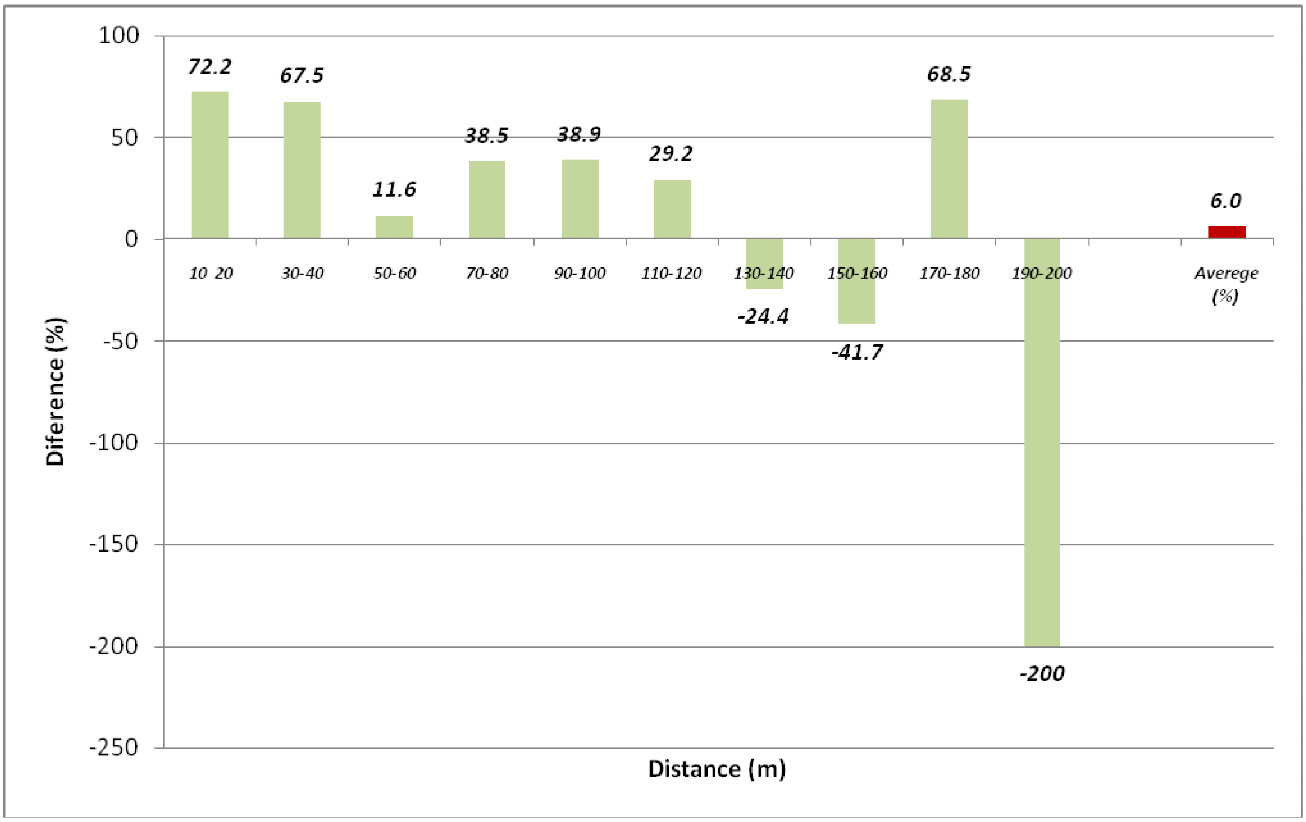


Figure 31. Reduction in plantules densities considering the impacts of logging in the area, by distance and total average.

Figure 31 shows that reductions of seedling density occurred more strongly at closer distances from mother trees. In longer distances, at 130 to 160 m and 190-200 m, as opposed to a reduction, ingrowth of plantules into the seedling stratum have occurred. Thus, for seedlings, an average reduction of density of only 6% was verified.

Grogan et al., (2003), studied the survival and growth rates of mahogany seedlings along a topographic gradient in order to verify whether it can be the basis for definition of the distribution pattern of mature trees, which occur in aggregations along streams Some experiments were established, planting seedlings developed in nurseries in the forest understory and in artificial treefall gaps in low-ground hydromorphic soils and high-ground dystrophic soils.

The authors pointed that after 3.5 years of observations, the survival and growth of seedlings were higher in treefall gaps than in the forest understory, even though the average survival rate of seedlings in the forest understory has been higher than the survival rate in treefall gaps, showing a low reduction of seedlings density, as observed in the present study.

On the other hand, the same authors, concluded that the soil conditions, that is, its high or low fertility, complement the disturbances regime in the forest canopy (increasing the incidence of light), so that the density of seedlings may vary depending on the size of treefal gaps (degree of disturbance in the canopy) and soil fertility.

3.3 HEIGHT GROWTH OF SEEDLINGS

Mahogany (*Swietenia macrophylla* King) trees are spatially distributed in the forest, generally in clumps influenced by environmental conditions such as topography, soil type and moisture and light availability throughout his life. In the Western Amazon region (Acre-AC), in steep slopes terrains, the population of mature mahogany trees, usually with large diameters and tall sizes, are distributed according to the river drainage network, including streams either temporary or seasonal, known as seasonally dry rivers; perhaps that is the reason why the degree of gregariousness is less evident than in the southeastern Pará State, where the topography is less steep (Figure 32).

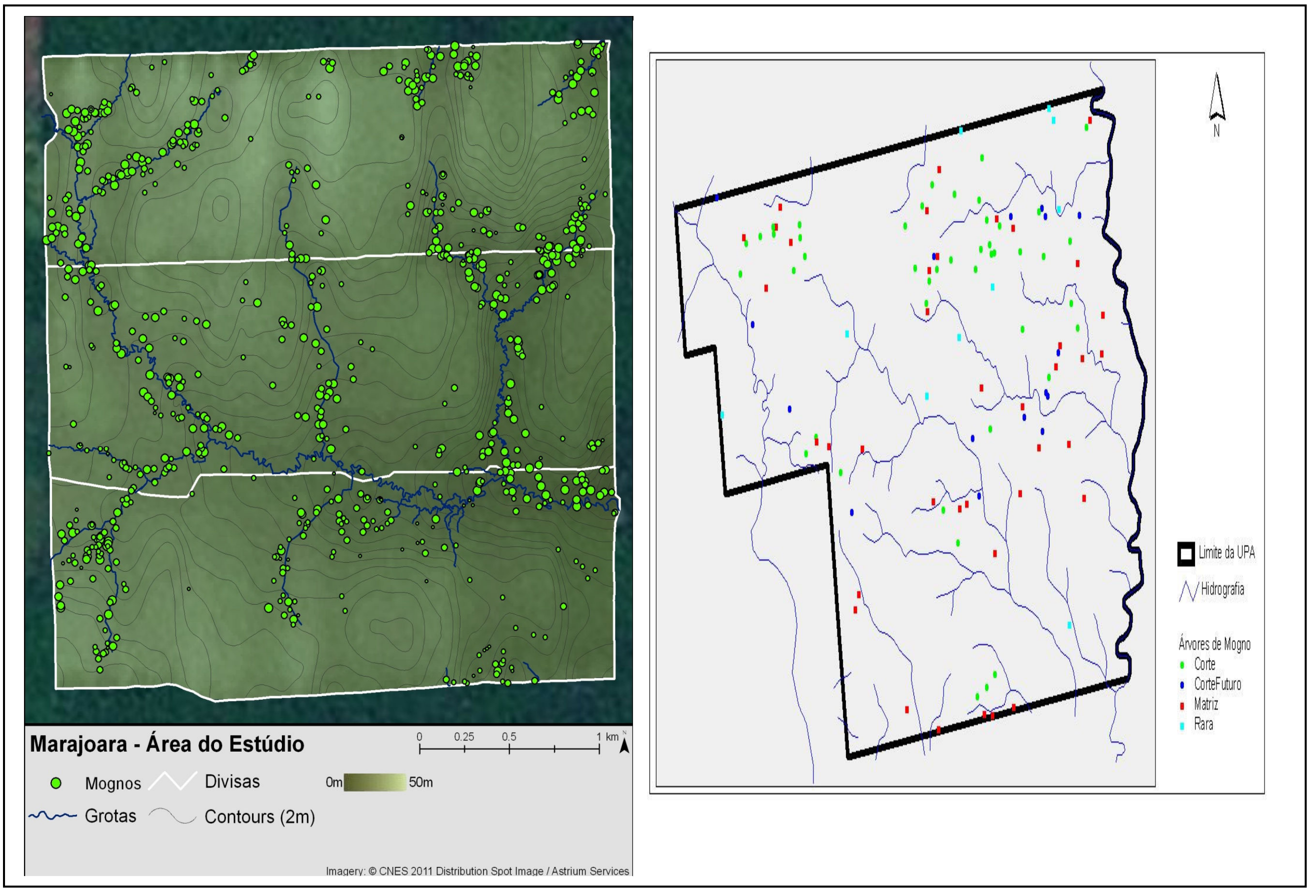
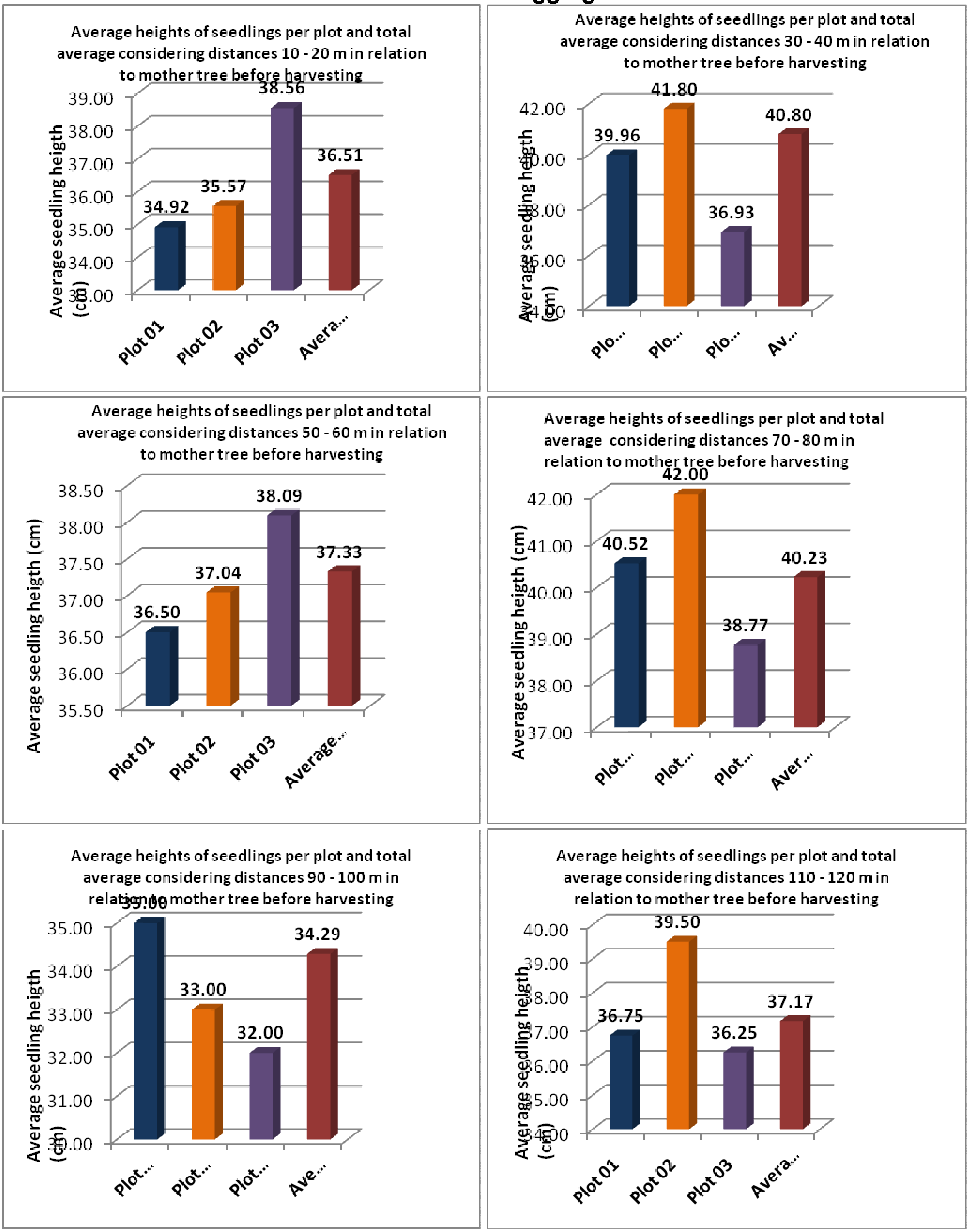


Figure 32. (A) Spatial distribution of mahogany individuals in the Fazenda Marajoara, in Southeast of Pará State, Brazil (Source: Presentation of Jimmy Grogan, during the 3rd Latin America Workshop of ITTO-CITES Program, held in Brasilia on 15-17 February, 2011); (B) Spatial distribution of mahogany individuals in the Fazenda Seringal Novo Macapa, Acre state, in Western region of the Brazilian Amazon.

Therefore, the higher or lower density of plantules and seedlings depends also on the location where the seeds can germinate and grow. However, the establishment of seedlings is directly related to greater or lesser degree of growth vitality of these individuals in its initial phase of life.

Figure 33 presents Histogram the variation of heights of seedlings depending on the distance per plot before harvesting.

Histogram of seedling heights depending on the distance
Phase I : Pre-logging



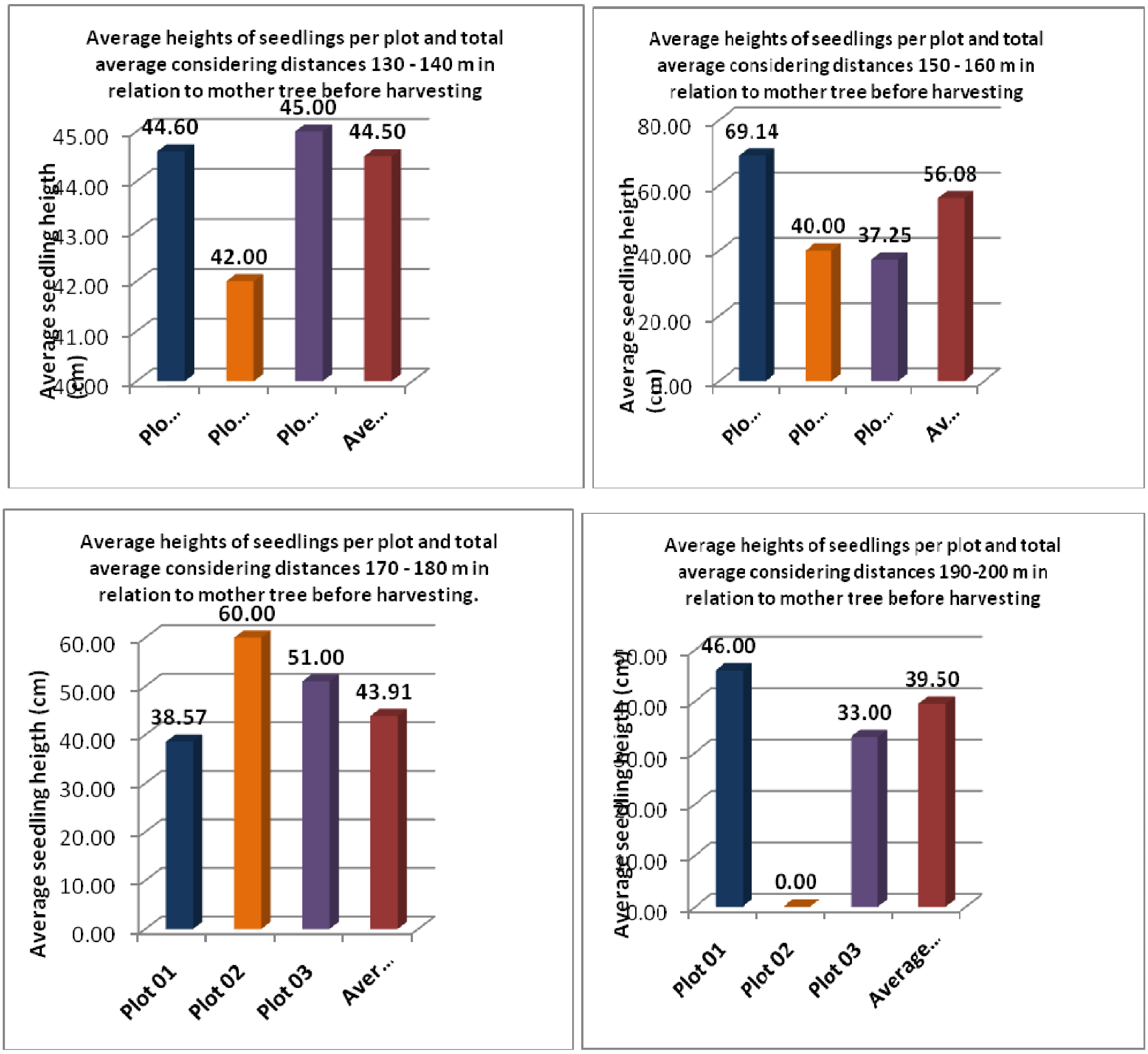


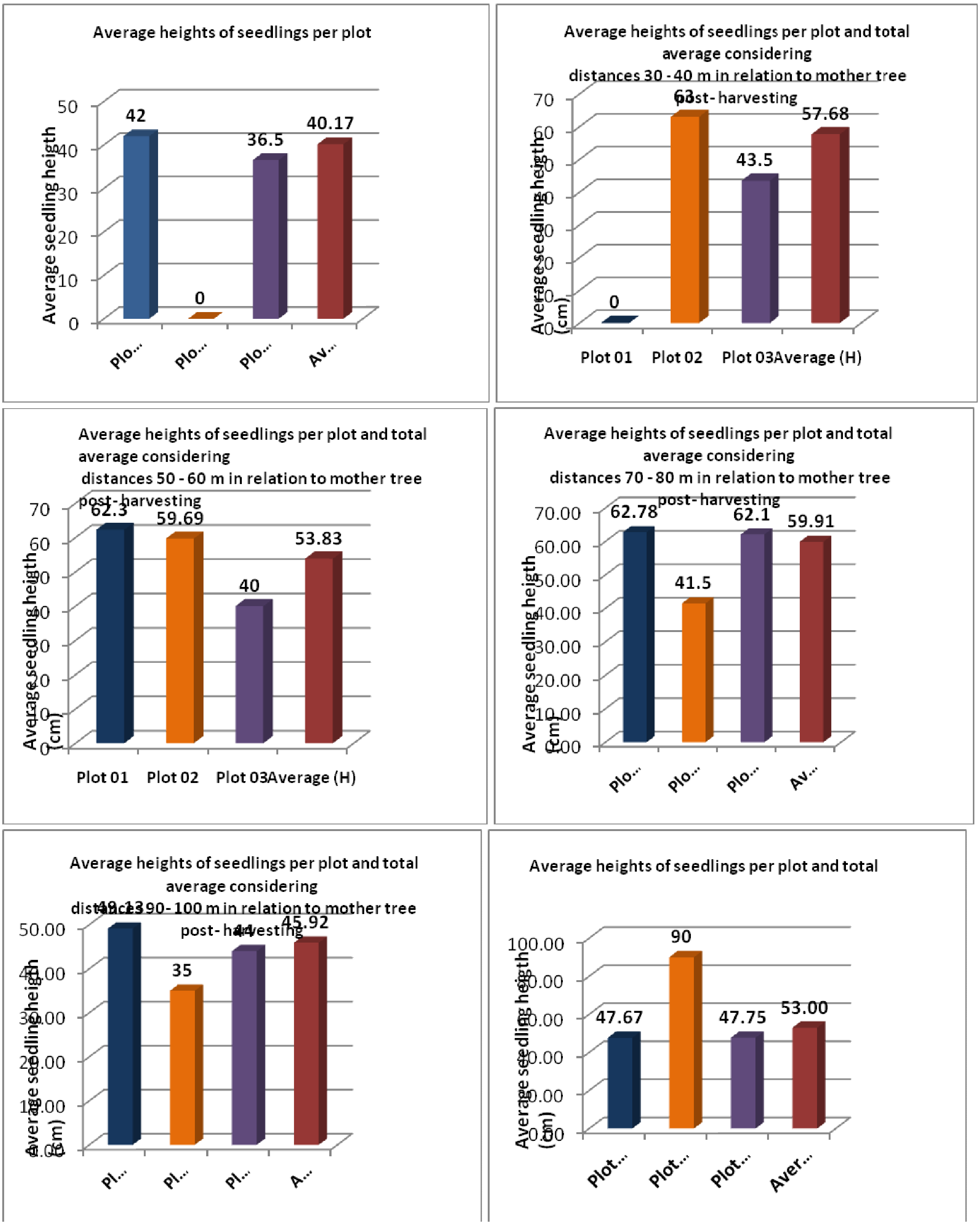
Figure 33. Average heights of seedlings per plot and total average considering distances of occurrence in relation to mother tree before harvesting.

The average heights of seedlings at the distance of 150-160 m in Plot 1 was 69.1 cm, but at 90-100 m distance in Plot 3 the average hight was only 32 cm, in addition to the non-occurrence of seedlings in Plot 2 at 190-200 m distance.

Before harvesting there were fully established seedlings with heights exceeding 1 m, and therefore the environmental conditions were satisfactory for plantules to grow into the seedling size. Therefore, we can infer that one possible indicator for enrichment planting with mahogany is places where adult trees are already occurring. This would probably meet the environmental conditions, soil type, moisture and topographic gradient required by the species leaving to forest managers to control light intensity as long as possible.

Figure 34 presents the variation of heights of seedlings per plot after harvesting of the UPA-1R area.

Histogram of seedling heights depending on the distance
Phase II : Post-harvesting



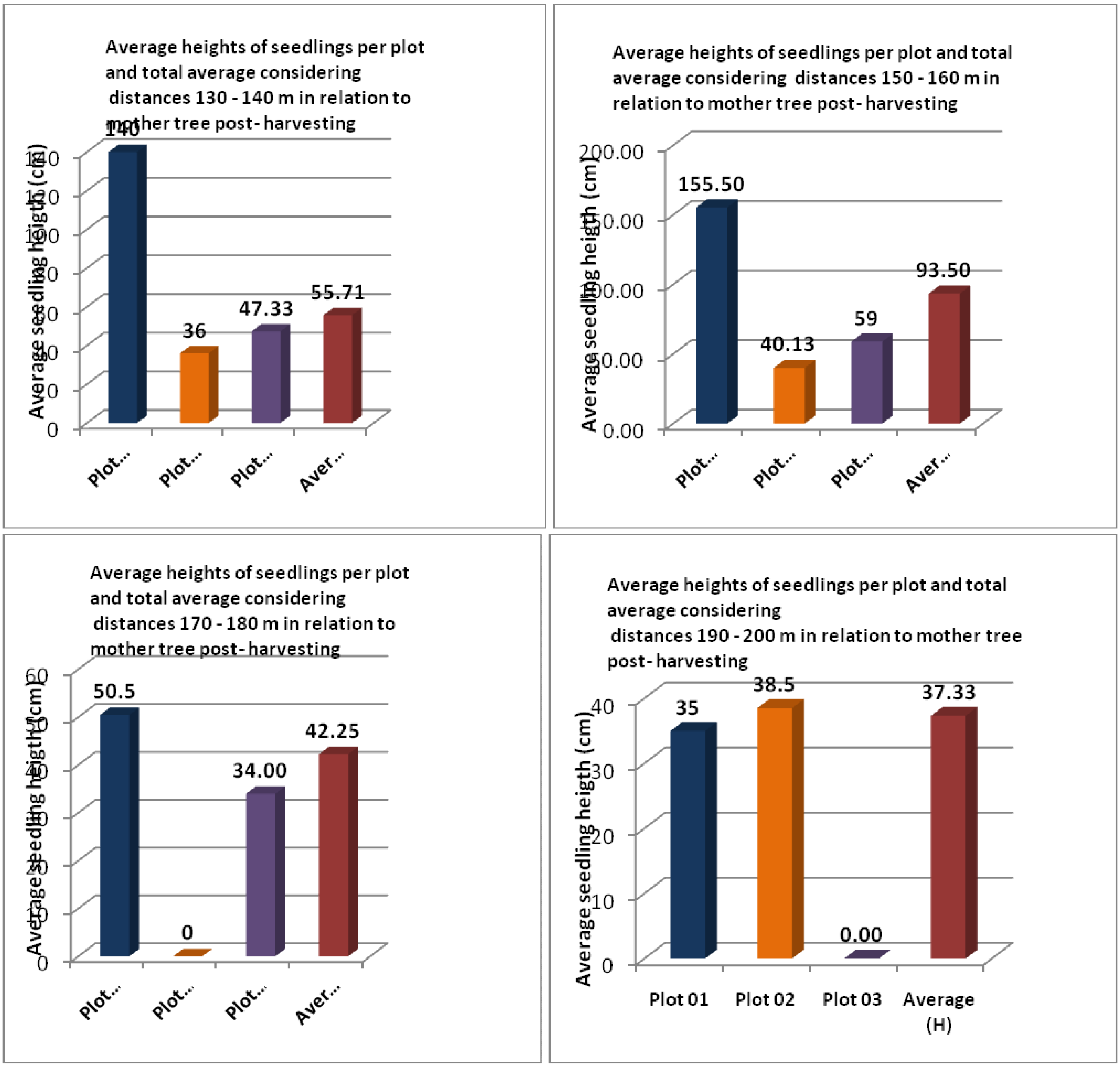


Figure 34. Average heights of seedlings per plot and total average considering distances of occurrence in relation to mother tree soon after harvesting

No seedlings were found in Plot 02 at the distances 10-20 m, 30-40 m, 170-180 m and in Plot 3 at the distance 190-200 m. Therefore these plots were considered as zero plots for the height measurement.

On the other hand, in Plot 1, 14 months after the first measurement, the average heights recorded at the distances 130-140 m and 150-160 m were 140 cm and 155.5 cm, respectively (44.6 cm and 69.1 cm before logging). In this plot, which was not affected by logging, average height growth ranged from 86.4 to 95.4 cm, despite the strong influence of bamboo. Figure 35 shows the average heights of seedlings per Plot in pre- and post-harvesting phases. It is observed that in three Plots the average seedling heights measured in the post-harvesting phase were all higher compared to those obtained in the pre-harvesting phase.

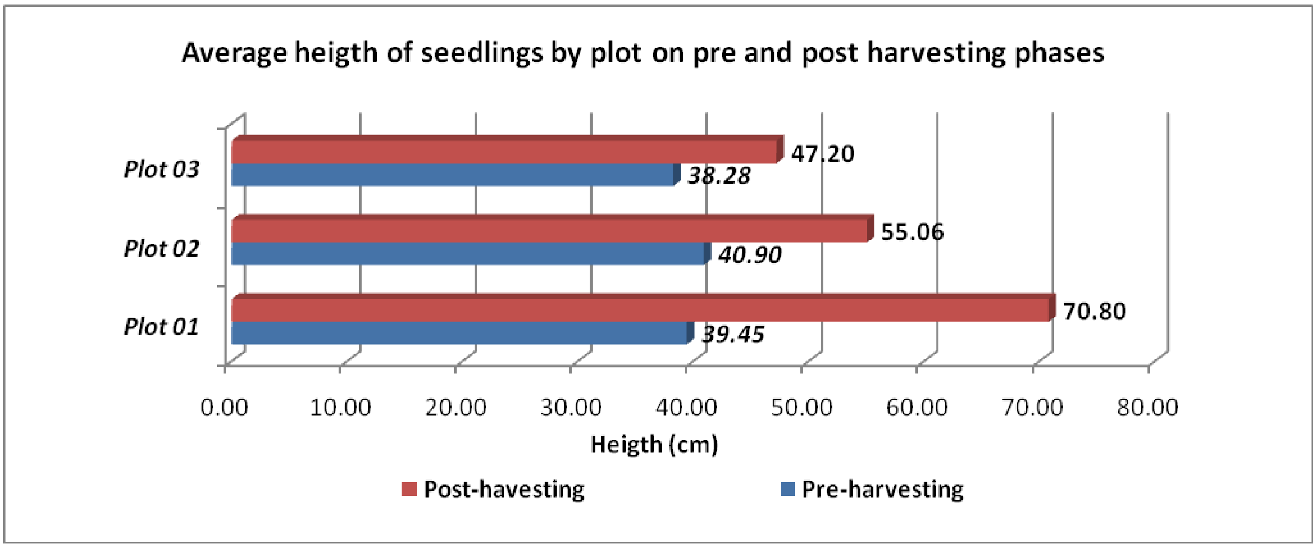


Figure 35. Height of seedlings per plot before and after logging.

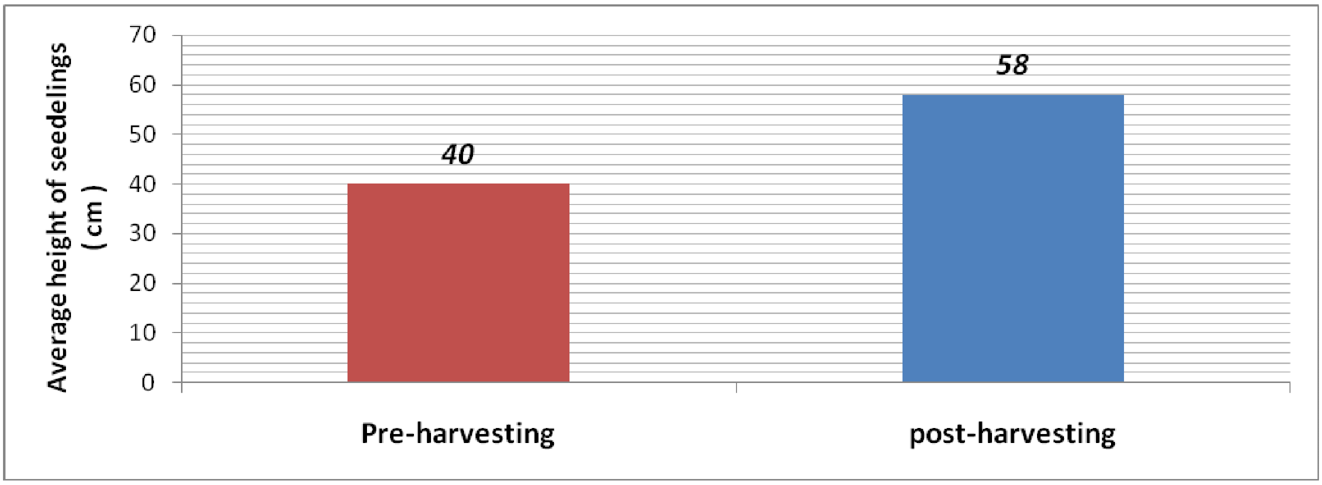


Figure 36. General average height of seedlings before and after logging.

Figure 36 shows that the general height averages of seedlings, were 40 cm and 58 cm in pre- and post-harvesting phases, respectively. This small difference after 14 months was due to the impacts of logging that caused mortality rates of 75.7% and 6% in plantules and seedlings, respectively.

Grogan et al., 2003 studying the growth of seedlings planted in nurseries using soil from high and low lands, found that seedlings planted in soils of low land grew more than those planted in high lands solis. According to the authors, the differences were due to soil nutrients, especially Ca and Mg.

Grogan and Galvão, 2006b, point out that low land soils that occur in the southeast of the State of Pará, near the Redenção municipality, are hydromorphic, with low moisture retention during the dry season, and a relatively high concentration of macronutrients in the surface horizon, conditions that have influenced positively height seedlings growth in the nursery. On the other hand, the authors also mention that high land soils are dystrophic, well-drained during the rainy season, fine texture, which allows greater moisture retention and less concentration of macronutrients in surface horizons compared to of low land soils.

Swietenia macrophylla King, according to Lamb, 1966 and Barros et al, 1992, occurs in various soil conditions, from deep, poorly drained soils, acidic clay soils to well-drained alkaline soils from limestone plateaus.

The soils of the area of natural occurrence of mahogany are those typical of areas subject to periodic flooding (hydromorphic), as well as and upland soils (podzolic soils), typical of the Western Amazon region (Figure 83). For Sombroek & Sampaio, 1962, of mahogany occurs predominantly on yellow Podzolic soils with high base saturation and with imperfect drainage and rich in exchangeable bases.

In General, in open ombrophylous forests, occurring in the southeast of the State of Pará, the soils are more sandy, with low levels of Ca and Mg, by the lack of moisture retention capacity (low CTC - Cation exchange capacity). Topography is less undulating than in the Western Brazilian Amazon, with strong predominance of lianas (vines).

Figure 37. Red Yellow Argisols known locally as "Tabatinga"

On the other hand, in the Western Brazilian Amazon, particularly in the State of Acre, the site of the present study, the soils are dense clay (podzolic soil), with most micropores that allow greater moisture retention during the dry season, with levels of Ca, Mg, organic matter and K higher than the sandy soils of the southeast of the State of Pará. These soils are known in the region as “tabatinga”, a clay soil with proportion 2 to 1, which retains more moisture, and at the same time making it difficult the transport of logs during the rainy season (Figure 37). The topography of this region is irregular, more undulating and with a high occurrence of bamboo *Guadua* sp species known locally as “taboca”.

As for soil, some general data on climate of the Western region of the Amazon are given: average annual precipitation is approximately 2,000 mm; average temperature varies from 23ºC to 26ºC, and lower temperatures may occur in individual cases, given the chill phenomenon, that occurs in the region between the States of Acre and Rondonia for 3 to 80 days per year. According to Grogan and Galvão (2006b), in the Southeast of Pará, in the surrounding area of the Redenção municipality, the annual average rainfall is 1,859 mm, with approximately zero precipitation during the dry season, from June to August.

Thus, it is expected a higher growth of seedlings in areas of the Western Brazilian Amazon than in the Southeast of Pará, because the seedlings respond better to soils with high levels of nurientes (Ca, Mg, organic matter and K) and more moisture during the dry season, since the average annual rainfall between the regions do not show major differences. However, mahogany natural regeneration, does not depend only on soil conditions, but also on high amount of light, which depends on formation of treefall gaps or strong interventions in the forest canopy.

As in the areas of the Western Brazilian Amazon, particularly in the open ombrophylous forests where mahogany occurs, the presence of vines (lianas) is less intense than in the Southeastern region of the State of Pará, Brazil. However, there is a strong occurence of bamboo that prevents the incidence of light to the forest floor (Figure 38) and therefore hampers mahogany natural regeneration; management of the species in this area, would need a constant control of "*tabocal*", increasing the costs, which could hinder the management of species.

Figure 38. Areas of treefall gaps completely covered by bamboo, dominating mahogany plantules and seedlings.

3.4 ENRICHMENT IN TREE FALL GAPS

Given the difficulties observed for the establishment of magogany natural regeneration, by initiative of Batisflor company seedlings were prepared and in the nursery and planted in treefall gaps opened after logging activities, as well as along the access roads (Figure 39).

Figure 39. (A) Partial view of the nursery; (B) Partial view of a treefall gap; (C) Preparing for planting; (D) Planting magogany seedlings; (E) Mahogany seedlings established; (F) Mahogany seedling 9 months old.

After planting of seedlings in treefall gaps, they were protected from the mahogany shoot borer attack (*Hypsipyla grandella*, Zeller), through the use of insecticide called "Colacide" in drops (Figure 40). Thus, protected and planted in good soil fertility, humidity and luminosity, growth of more than 1.8 m in height in the period of 9 months was observed.

Figure 40. (A) Application of Colacid in drops; (B) Seedling protected against mahogany shoot borer attack; (C, D, E and F) 9 months seedlings old .

On the basis of preliminary results obtained from enrichment planting in treefall gaps, using fertilizers (Ca and Mg), and controlling the shoot borer with "Colacid", it is possible to ensure a good stock of future trees However the economic viability of this kind of management still need to be evaluated.

4. FINAL CONSIDERATIONS

In the Post-harvesting Phase (Phase II), considering the fact that the data was collected immediately after logging, the analyses do not reflect the dynamics (recruitment, mortality and growth) of *Swietenia macrophylla* King (mahogany). It only shows the impacts of logging on pre-existent stocks of natural regeneration. The assessments revealed a strong impact of logging with 75.7% reduction in plantules stocks, and a relatively low impact on seedlings of only 6%. It has been observed that at greater distances (190-200 m), the impact has been small, and promoted an increase in the stocks of seedlings.

Seed dispersal proved to be efficient, because on average there was dispersal in all distances evaluated (10 m to 200 m). The highest densities occurred at distances 145 m and 104 m for plantules and seedlings, respectively in Pre-harvesting Phase (Phase I). In the Post-harvesting Phase (Phase II), the impacts of harvesting, resulted in a decrease in the average distance of plantules dispersal to 61 m; conversely, there was an increase in the distance of seedlings occurrence to 123 m. This fact demonstrates that mahogany has great ability for seed dispersal, covering large areas with natural regeneration. Seedlings were less affected by anthropic actions.

The area of seed dispersal of a mahogany tree in the study area, considering only the West side of the prevailing wind direction was 6.28 ha.

The growth of seedlings in height was extremely vigorous in its initial phase. Growth rates ranged from 56% to 68% (mean=33%) after logging. It can be expected higher growth rates if bamboo (*Guadua* sp) is controlled, which causes suffocation of mahogany plantules and seedlings.

The management of mahogany in the Western region of the Brazilian Amazon in the State of Acre (AC), Brazil, should be associated with enrichment planting in treefall gaps, along the roads and logging trails, preferably using fertilizers and frequent control of bamboo vegetation, as well as the control of the mahogany shoot borer attack *Hypsipyla grandella*, Zeller. This will require, however, economic evaluation of its feasibility.

Based on the current legislation that regulates forest management plans with occurrence of mahogany (Instruction No. 07 of 22/08/2003 - IBAMA/MMA), it was initially planned to harvest 45 (41.0%) mahogany trees with minimum DBH felling limit of 60 cm, out of 110 trees inventoried. However, only 30 (27.3%) were effectively harvested, resulting in a volume of 538.212 m³, with an average 17 m³ per tree. It is unlike that the same volume will be harvested, in a second cutting cycle, in keeping the current regulations in effect in Brazil. The average volume of secondary species was approximately 8 m³ per tree, from a relatively small number of species of commercial value. The same situation is unlikely to be found in the second cutting cycle. Thus, we point out that in keeping the current legislation, the management of forests with occurrence of mahogany would not feasible from the silvicultural point of view.

Silviculture of mahogany forests in Brazil, should consider, in addition to natural regeneration, controlling bamboo and introducing enrichment planting in gaps and other open sites. Otherwise, the economic future of wood production of mahogany in the Brazilian Amazon will only be feasible in reforestation areas and or in agroforestry systems.

Although mahogany seed dispersal is efficient, high mortality rates were observed as result of a number of limiting factors, such as the attack of pests, soil moisture level and especially the occurrence of vines (lianas) and bamboo. Thus, to ensure the species conservation it is crucial the application of silvicultural treatments in managed forests and other silvicultural alternatives such as reforestation and agroforestry systems, as it has also been proposed by Grogan et al. (2010).

Management of mahogany forests in Brazil should comply with two regulations: Instruction N° 05, IBAMA/MMA), that regulates management of non-mahogany forests and Instruction N° 07, IBAMA/MMA, which sets out the rules for minimum cutting diameter of 60 cm, the preservation of 20% of commercial trees, and maintenance of 5 trees per UT[1] (Work Unit - area of approximately 100 ha), and other legal restrictions common to all species, which is the logging prohibition in permanent preservation areas (APP).

In the specific case of mahogany that is distributed in a gregarious form along the streams/ rivers, the rules become more restrictive, since the occurrence of temporary or seasonal streams are frequent, due to undulating topography. It is noteworthy that trees that occur in APPs are not considered in the calculation of the 5 individuals per UT to be kept, that is, in each UT at least 5 trees with DBH ≥ 60 cm should be preserved, in addition to those found in APPs. For this reason, in order to comply with the legislation, out of 110 mahogany trees inventoried in the UPA-1R, only 30 trees were harvested. Thus, even if silvicultural treatments that minimize the effects of limiting factors for mahogany management are carried out, but no changes are introduced in the present management regulations in order to release more individuals to be logged, it is doubtful if forest management in a second cutting cycle would be economically viable, once the remaining trees of the first cutting cycle cannot be logged either because they are located in APPs or they are considered rare within the UT.

Swietenia macrophylla, King is regarded as a fast growing species, with its plantules growing more than 1 m/year in height. According to Grogan[2], diameter growth is, on average around 0.65 cm/year for all diametric classes. The average increment of mature trees is *c.* 1.0 $cm.year^{-1}$, and trees with diameters smaller than the minimum felling diameter (60 cm), that are the remnants of logging operations, can grow up to 1.5 cm/year.

If only the remnant trees were considered, and if the annual increment was linear there would be a growth of 45 cm in 30 years. Therefore only trees with DBH ≥ 15 cm would reach the minimum felling diameter of 60 cm at the end of the cutting cycle. However, the

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[1] Keeping 5 trees per UT is called rareness in the Brazilian Mahogany Forest Management regulations, i.e, if only 5 individuals are present in a particular UT, the species is considered rare at that UT and therefore all individuals must be preserved.

[2] Presentation of Jimmy Grogan during the "3rd Taller Latino Americano del ITTO-CITES Program", held in Brasilia on 15-17 February, 2011).

number of these trees is very small, and if the current regulations that governs management of mahogany in natural forests remains in place, the number of trees available for logging in the 2nd cutting cycle, would also be too small. The average volume per tree will be much lower than the current 17 m^3 per tree, and therefore it is possible to expect a low economic viability in the 2nd cutting cycle.

Thus, in order to ensure the implementation of silvicultural activities during the management cycle, the two forest management regulations for tropical rain forests in the Brazilian Amazon (Instruction nº 05 and Instruction nº 7) should be revised and merged in order to assure economic viability of forest management, without jeopardizing species conservation.

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