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Assessment of Seed Bank Dynamics in a Regenerating Tropical Rainforest Ecosystem in South-Western Nigeria

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ABSTRACT
The species composition, density, and distribution of soil seed banks have been the subject of investigations to designate the viable seed reservoir present in a soil. The study assessed the seed bank dynamic in view to regenerating tropical rainforest ecosystem in South-Western Nigeria. The study area is located in the International Institute of Tropical Agriculture (I.I.T.A) campus, Ibadan, Nigeria. Soil samples were collected from each of the twenty-four 25 x 25m sampling plots at 0-15 cm depth under closed forest canopy with an auger of 8.5cm diameter. All seeds that germinated from each of the soil samples were identified using Hutchinson (1952-1972), recorded at 3 days interval and observed for six months. Seedlings of species per plot, variation in emergence seasonally and total seed bank was computed. Simpson's species diversity and similarities indices were used to compare species similarity and diversity. The results showed that a total of 7,857 seedlings from 49 species emerged during the period of the study. The highest number of seedling emergence of 580 seedlings was found in plot 6 while the least was found in plot 70 (179 seedlings). Species with the highest seedling emergence is Chromolaena odorata (1,278) and the least seedling emergence includes Mucuna flagellipes (4). The highest number of the seedlings (338) was recorded at the middle of the raining season (June), 324 seedling at the early raining season collection (April), and the lowest (202) at the late raining season (September collection). The similarity indices showed that plot 14 and plot 26 were the most similar (88.89%) while the least similar plots was plot 49 and 84 (26.67%). In terms of species diversity, plot 68 has the highest species diversity of 0.9384 with 31 species, while the least was found in plot 76 (0.8424) with 18 species. With respect to the interactions between seed bank and the standing vegetation, the result showed a large discrepancy between the seedlings from the seed bank and the standing vegetation.

Keywords: Seed bank, herbaceous species, seedling emergence

INTRODUCTION
The term soil seed bank has been used to designate the viable seed reservoir present in a soil (Roberts, 1981). According to Baker (1989) this reservoir corresponds to the seeds not germinated but, potentially capable of replacing the annual mature plants, which had disappeared by natural death or not, and perennial plants that are susceptible to plant diseases, disturbance and animal consumption, including man. All the viable seeds present in the soil or mixed

to soil debris constitute the soil seed bank (Simpson *et al.*,, 1989). The soil seed bank is the life cycle origin for the annual species, being fundamentally the cause of its persistence; in perennials, besides the seed bank, there is a bank of vegetative propagules like tubers, rhizomes and stolons (Fernández-Quintanilla *et al.*, 1991). Tropical soil seed banks are considered important regeneration resources during secondary succession or gap dynamics within rain forests (Hopkins and Graham 1984, Young *et al.,* 1987, Garwood 1989, Thompson 1992, Dupuy and Chazdon 1998). Many soil seed banks consist primarily of pioneer species or weed species from adjacent disturbed areas (Young *et al.*, 1987, Thompson 1992, Dalling and Denslow 1998, Metcalfe and Turner 1998, Saulei and Swaine 1998). The persistence and distribution of seeds in the soil are known to be largely determined by seed size and shape (Thompson 1992, Bekker *et al.,* 1998, Guo *et al.,* 2000). The size and species composition of the soil seed bank vary seasonally as changes in transient and seasonal transient seed banks (Garwood 1989), and this change largely coincides with the fruiting phenology of forests (Grombone-Guaratini and Rodrigues 2002). Seeds of primary species rarely occur in the soil seed bank of tropical rain forests due to large seed size, high water content, and rapid germination strategies (Vazquez-Yanes and Orozco-Segovia 1993). As a result, the species composition of soil seed banks differs considerably from the species composition of the forest canopy (Garwood 1989). The species composition, density, and distribution of soil seed banks have been the subject of investigations that also consider forest fragmentation and regional disturbance (Hopkins and Graham 1984, Quintana-Ascencio *et al.,* 1996, Cao *et al.,* 2000). The study assessed the seed bank dynamic in view to regenerating tropical rainforest ecosystem in South-Western Nigeria.

Materials and Methods

The study area is located on the one thousand hectares land in the International Institute of Tropical Agriculture (I.I.T.A) campus at Idi-Ose, North of Ibadan. It is located on longitude 7° 30′N and latitude 3° 55′E and 243m above sea level. The rolling topography is dominated by slopes that are 3-10% (Ano. 1967, Moormann *et al.,* 1975). The area is underlain by metamorphic rocks of pre-cambrian basement complex, consisting largely of banded gneiss alternating with strata of quartzites and quartz schists. The soils are predominately Ferric Luvisols (Moormann *et al.,* 1975).

It is (IITA) within the humid tropical lowland region with two distinct seasons: the longer wet season and shorter dry season. The rainfall pattern has bimodal peak with an annual total ranges between 1,300-1,500mm most of which falls between May and September. The average daily temperature ranges between 21°C-23°C while the maximum is between 28°C and 34°C. Mean relative humidity is in the range of 64-84% (Hall and Okali, 1979, Osunsina, 2004).

In other to assess the soil seed store and its variability in space and time, soil sampling for investigation of seed bank was done between April, June and October, 2011, to increase the probability of finding species with different germination requirements (Dry and Rainy seasons). Soil samples were collected from each of the twenty-four 25 x 25m sampling plots. Three soil samples 5 x10 cm at 0-15 cm depth were collected under closed forest canopy from each of the sampling plot at random with an auger of 8.5cm diameter, During the collection of the soil samples the distance between the collection of one soil sample to the other

was not less than 5 m and were not collected near the edge of the site.

Each soil sample was carefully placed in a wooden box 25 x 25 x10 cm and labeled. Each of the boxes containing soil samples was loosely covered with a black polythene sheet to avoid contamination during transportation to an open place.

Samples were kept moist by sprinkling of water on them daily from the second day of collection to the last day of observation. All seeds that germinated from each of the soil samples were identified using Hutchinson (1952-1972) and recorded at 3 days interval. The total number of each individual species that germinated in each box were summed up and recorded at the end of every seven days. Observation of each soil sample was done for six months. Seeds that germinated in each of the box were classified into climax and pioneers trees, climbers or herbs. The data sets for April, June and October were pooled, whereby seed densities were summed. Number of seedlings of all species per plot were estimated, variation in seedling emergence seasonally and total seed bank among the plots were also computed. Simpson's species diversity and similarities indices were also used to compare the similarity in species composition and species diversity among plots in each sampling season. The percentage contributions of each species to the seed bank were also determined seasonally.

Results

Seedling Emergence

A total of 7,857 seedlings from 49 species (Table 1) emerged during the period of the study. The highest number of seedling emergence of 580 seedlings was found in plot 6, followed by plot 8 (552 seedlings), plot 69 (447), plot 68 (459). The least was found in plot 70 (179 seedlings), followed by plot 37 (202 seedlings). Species with the highest seedling emergence was *Chromolaena odorata* (1,278), *followed by Dillenia indica* (705), *Chassalia kolly* (417), *Carpolobia lutea* (368). The species with the least number of seedling emergence include *Mucuna flagellipes* (4), *Croton lobatus* (7), *Bidens pilosa* (21).

Herbaceous plants dominated the life form of the seed banks in all the twenty-four plots, Some of the herbaceous species that dominate the site during the two seasons (six months) include; *Ageratum conyzoides, Chromolaena odorata, Oldelandia corymbosa, Peperomia pellucida,* and *Solanum erianthum.* Twenty –six families were from forty nine species were encountered in all the studied plots, however, Poaceae, Moraceae, Leguminosae, Malvaceae are the most common families (Table 2) .Of all the 49 species only seven are tree species this include; *Antiaris toxicaria* (119), *Albizia zygia* (154), *Leucaena leucocephala* (101*), Morus mesozygia* (240*), Ficus capensis* (11º), *Lecaniodiscus cupanioides* (156), *Anogeisus leiocarpus* (103), *Alchornea cordfolia* (97) and all these account for 10.99% of the total seedlings that emerged.

Table (2) revealed that there was a fluctuating trend in the density of the woody species that emerged from the soil seed bank of the 24 studied plots as the season progresses. The highest number of the seedlings (338) was recorded at the middle of the raining season (June), 324 seedling at the early raining season collection (April), and the lowest (202) at the late raining season (September collection). All woody species germinated during the two seasons (six months)

The similarity indices of the seed banks species composition in the 24 study plots was calculated using Simpson's similarity. Table 4 showed that plot 14 and plot 26 were the most similar (88.89%) followed by plot 8 and plot 95 (87.5%), plot 6 and plot

95 (81.25%). The least similar plots include plot 49, and plot 84 (26.67%), plot 67 and plot 70 (28.57%), plot 70 and plot 84 (35.71%), plot 28 and plot 97 (28.41%).

In term of species diversity plot 68 has the highest species diversity of 0.9384 with 31 species, followed by plot 86(0.929), 23 species. The least was found in plot 76 (0.8424) with 18 species, plot 28 (0.824) with 17 species (Table 3).

DISCUSSION

The higher seedling densities recorded in all the study plots can be ascribed to the preponderance of herbaceous species in the seed bank of the study plot and; longer time allow for the seedlings emergence, which probably gave room for more seeds to overcome their dormancy and germinate. Herbaceous species dominated the seeds banks. This observation could be due to little openings in the forest canopy at the study plot which allows the dispersals of seeds of this herbaceous species to the study site. Isichei (1995) stated that the opening of forest canopy allows germination of herbaceous species. The dominance of herbaceous species in the seed bank of forest soil as recorded in this study has been reported by various workers (Miller, 1999, Cao *et al.*,, 1997, Oke *et al.*, 2006). The presence of few woody species in the seed banks may be due to the low seed production or lack of definite (or no) dormancy mechanism in most woody species. However there were more seedlings of woody species in the seed bank during the mid- raining season (June collection) than any other time. This agrees with the findings of Chandrashekera and Ranakrishnan (1993) and Oke *et al.*, (2006) which reported a high density of viable seed/ seedlings during the season. Index of similarity (28-88%) for the seedlings that emerged from the seed banks in this study indicate a high level of similarity in species composition of the seed banks.

The interactions between seed bank and the standing vegetation, showed a large discrepancy between the seedlings from the seed bank and the standing vegetation. This is similar to earlier reports by Thompson and Grime (1979), Staaf *et al.*, (1987) and Warr *et al.*, (1994). A few of the total species from the seed bank are common to those found in the standing vegetation. This includes *Chromolaena odorata*, *Chassalia kolly, Carpolobia lotea*, *Antiaris toxicaria*, *Lecaniodiscus cupanioides, Albizia zygia, Alchornea cordifolia.* This can be explanined by the fact that only a few forest species produce long-living seeds of proclimax species (Kjellison, 1992; Warr *et al., 1994;* Brurnet and Vandheimn, 1998). The absence of the most abundant forest species from the seed bank could suggest that these species mainly reproduce through vegetative propagation. Their absence in the seed bank can be explained by a potential clumped occurrence of seed, just beneath the litter cover but incorporated in the soil, so that the small samples may fail to detect seeds.

In addition, the absence of seedling with large seeds in the seed bank study could be due to the fact that large seeds are transient in the seed bank because they do not have long dormancy periods (Swaine, 2001, Martins and Engel 2007) and, as a result, their number in the soil seed community is reduced (Dalling and Hubbell 2002). Another potential factor affecting the low representation of large seed seedling species is the higher predation risk that these face in a maturing forest (Schupp *et al.*, 1989).

Table 1: Density of Seedling that Emerged in the Twenty Four Study Plots

	Plots											
Plant spp	**6**	**8**	**14**	**17**	**26**	**28**	**30**	**37**	**41**	**48**	**49**	**57**
Abutilon muritianum	0	0	0	0	0	0	0	0	6	13	6	0
Achyranthus aspera	29	0	4	16	5	0	0	0	0	1	51	20
Ageratum conyzoides	0	23	0	0	0	2	0	0	0	5	0	4
Albizia zygia	6	8	4	24	20	12	8	0	0	4	3	0
Alchornea cordifolia	0	12	6	0	18	0	12	13	0	11	5	0
Andr*opogon tectorum*	75	0	7	8	12	0	0	0	2	0	57	8
Anogeissus leiocarpus	8	13	6	0	0	0	0	19	9	7	0	6
Antiaris toxicaria	9	6	9	8	5	8	0	0	3	0	4	8
Aspilia africana	0	0	0	0	17	0	0	0	0	0	14	0
Bidens pilosa	0	0	3	0	0	0	0	0	0	0	2	0
Capsicum frutescens	0	0	15	4	58	0	18	0	0	0	0	0
Carpolobia lutea	0	34	13	0	12	0	21	35	6	0	29	43
Chassalia kolly	12	52	6	35	27	49	0	3	18	0	0	0
Chromolaena odorata	119	90	67	12	40	95	8	0	45	72	0	61
Cleome rutidospermum	0	0	2	5	3	0	0	0	0	0	0	0
Combretum hispidum	0	6	11	0	0	0	0	0	6	42	0	0
Commelina diffusa	0	0	18	4	16	27	0	0	0	0	18	0
Croton lobatus	4	0	0	0	0	0	0	0	0	0	0	0
Desmodium scorpiurus	0	0	0	5	0	0	21	0	0	0	0	0
Desmodium hirsutum	0	0	0	0	0	2	5	0	0	0	0	0
Digiteria horizontalis	55	0	0	23	0	0	0	0	0	0	0	0
Dillenia indica	36	74	46	0	41	43	38	13	43	20	34	49
Diodia sarmentosa	0	0	0	0	0	2	0	0	2	0	0	0
Eugenia spp	0	0	0	0	0	0	0	0	9	2	5	0
Ficus capensis	0	8	0	0	0	0	17	15	3	5	7	0
Indigofera hirsutum	4	0	0	0	0	0	0	0	0	0	0	0
Ipomoea triloba	0	0	4	0	0	2	0	0	0	0	0	0
Laportea aestuans	0	5	0	0	0	0	2	11	6	0	6	17
Lecaniodiscus cupanioides	12	7	21	15	19	0	0	0	46	27	0	31
Leucaena leucocephala	8	7	6	0	0	0	0	11	8	7	0	11
Mariscus flabelliformis	0	0	13	5	4	0	13	18	35	0	3	10
Morus mesozygia	0	6	4	0	0	0	0	0	0	0	0	1
Mucuna flagellipes	0	0	0	0	0	0	1	0	0	0	0	0
Mucuna pruriens	23	24	42	35	0	0	24	16	0	7	0	0
Oldenlandia corymbosa	0	4	0	2	0	0	0	0	12	0	0	0
Oxalis corniculata	5	6	12	12	0	4	0	0	0	0	0	0
Panicum maximum	0	12	0	12	0	0	0	0	0	0	5	0
Parquetina nigrescens	0	16	16	6	0	2	0	0	0	0	0	0
Perperomia pellucida	0	0	4	0	0	8	16	3	0	0	0	0
Physalis micrantha	0	0	4	0	0	2	0	0	0	0	0	5
Pupalia lappacea	0	0	0	0	0	0	0	2	17	0	0	9
Setaria barbata	0	0	1	0	0	2	0	0	0	0	0	0
Sida acuta	0	6	1	0	28	0	0	0	0	0	0	0
Sida corymbosa	77	7	26	7	0	3	0	0	0	0	0	0
Solanum erianthum	10	6	0	0	20	0	0	24	3	33	10	20
Spigelia arthelmia	43	41	37	9	3	0	0	0	0	11	0	5
Talinum triagulare	21	54	16	6	0	33	16	19	0	7	0	0
Tridax procumbens	24	25	0	0	0	0	8	0	0	8	0	1
Triumfetta cordifolia	0	0	0	0	0	0	12	0	0	0	0	0
	580	**552**	**424**	**253**	**348**	**296**	**240**	**202**	**279**	**282**	**259**	**309**

plant spp	**60**	**64**	**69**	**70**	**76**	**84**	**89**	**90**	**95**	**97**	**68**	**86**
Abutilon muritianum	1	1	0	0	0	0	4	0	0	13	6	0
Achyranthus aspera	0	1	0	0	2	0	8	4	37	1	51	20
Ageratum conyzoides	0	0	0	11	52	0	0	0	0	5	0	4
Albizia zygia	8	11	0	9	2	7	4	9	5	4	6	0
Alchornea cordifolia	0	2	0	0	0	0	0	0	0	13	5	0
And*ropogon tectorum*	0	46	0	3	0	0	0	5	0	0	50	8
Anogeissus leiocarpus	9	6	0	0	0	2	5	0	0	7	6	0
Antiaris toxicaria	5	0	11	9	3	4	3	4	5	4	7	4
Aspilia Africana	0	0	46	0	0	0	0	33	0	4	6	5
Bidens pilosa	0	0	0	2	0	0	0	3	0	4	4	3
Capsicum frutescens	0	0	0	0	0	0	0	0	0	17	13	0
Carpolobia lutea	0	23	54	0	0	12	18	31	8	6	14	9
Chassalia kolly	23	21	0	0	0	32	21	25	6	32	36	19
Chromolaena odorata	29	74	60	40	129	54	36	48	80	45	48	26
Cleome rutidospermum	0	0	0	3	0	0	0	20	0	7	0	0
Combretum hispidum	0	0	0	0	0	0	0	0	0	0	0	28
Commelina diffusa	0	3	0	0	0	0	5	3	0	0	0	0
Croton lobatus	0	0	0	0	3	0	0	0	0	0	0	0
Desmodium scorpiurus	0	4	0	0	2	2	9	19	1	0	6	0
Desmodium hirsutum	0	0	2	0	0	0	0	0	0	0	21	0
Digitaria horizontalis	0	10	23	0	0	0	0	0	0	0	8	4
Dillenia indica	30	45	0	25	24	0	37	34	21	0	31	21
Diodia sarmentosa	0	0	29	0	0	0	0	0	0	0	7	0
Eugenia uniflora	0	0	0	0	0	0	4	0	0	0	23	4
Ficus capensis	8	5	13	0	5	0	4	3	6	5	6	0
Indigofera hirsutum	0	0	0	0	5	1	0	0	0	0	0	7
Ipomoea triloba	0	42	0	0	0	0	0	0	0	0	0	8
Laportea aestuans	0	0	5	0	0	0	0	0	0	0	0	4
Lecaniodiscus cupanioides	67	9	85	6	0	3	5	7	1	0	0	0
Leucaena leucocephala	6	9	0	0	0	6	5	0	0	11	6	0
Mariscus flabelliformis	2	40	0	2	39	23	26	0	0	0	0	0
Morus mesozygia	0	0	3	0	4	0	0	0	0	3	3	0
Mucuna flagellipes	0	0	0	0	0	0	0	0	0	0	0	3
Mucuna pruriens	0	2	0	0	2	17	2	31	21	0	5	0
*Oldenl*andi*a corymbosa*	0	0	0	21	0	0	1	0	0	0	4	0
Oxalis corniculata	6	0	0	0	0	0	3	12	8	0	7	0
Panicum maximum	0	0	0	0	0	0	0	0	0	0	12	4
Parquetina nigrescens	0	0	0	3	22	0	0	0	0	0	14	23
Perperomia pellucida	0	0	0	0	0	0	0	0	0	0	3	0
Physalis micranta	12	7	0	26	0	0	0	0	0	0	23	6
Pupalia lappacea	24	64	43	19	0	0	0	5	0	0	0	17
Setaria barbata	0	9	0	0	0	0	0	0	0	0	0	0
Sida acuta	0	0	0	0	0	0	0	0	0	0	0	0
Sida corymbosa	0	0	0	0	0	0	9	1	29	0	0	0
Solanum erianthum	25	4	0	0	0	0	0	12	51	36	0	0
Spigelia arthelmia	0	0	17	0	34	1	12	0	0	6	0	0
Talinum triagulare	0	7	56	0	41	7	42	0	4	0	5	0
Tridax procumbens	0	6	0	0	37	48	7	12	7	3	23	28
Triumfetta cordifolia	0	0	0	0	2	0	10	42	0	2	0	3
	255	**451**	**447**	**179**	**408**	**219**	**280**	**363**	**290**	**228**	**459**	**258**

Table 2: Plant, Family and Density of Seedling that emerged in the Twenty-four study plots

Plant Spp	Family	Form	Density
Abutilon mauritianum	Malvaceae	Shrub	50±3.96
Achyranthes aspera	Amaranthaceae	Herb	250±16.14
Ageratum conyzoides	Asteraceae	Herb	106±11.37
Albizia zygia	Fabaceae	Tree	154±6.01
Alchornea cordifolia	Euphorbiaceae	Shrub	97±5.78
And*ropogon tectorum*	Poaceae	Grass	281±21.49
Anogeissus leiocarpus	Combretaceae	Tree	103±5.04
Antiaris toxicaria	Moraceae	Tree	119±3.18
Aspilia Africana	Asteraceae	Herb	125±11.64
Bidens pilosa	Asteraceae	Herb	21±1.45
Capsicum frutescens	Solanaceae	Herb	125±12.74
Carpolobia lutea	Polygalaceae	Shrub	368±15.42
Chassalia kolly	Rubiaceae	Shrub	417±16.29
Chromolaena odorata	Asteraceae	Herb	1278±33.97
Cleome rutidospermum	Capparaceae	Herb	40±4.32
Combretum hispidum	Combretaceae	Shrub	93±10.17
Commelina diffusa	Commelinaceae	Herb	94±7.59
Croton lobatus	Euphorbiaceae	Herb	7±0.10
Desmodium scorpiurus	Fabaceae	Herb	69±5.79
Desmodium hirsutum	Fabaceae	Herb	30±4.36
Digitaria horizontalis	Poaceae	Grass	123±12.57
Dillenia indica	Dilleniaceae	Tree	705±18.20
Diodia sarmentosa	Rubiaceae	Herb	40±6.01
Eugenia uniflora	Myrtaceae	Tree	47±5.02
Ficus capensis	Moraceae	Tree	110±4.94
Indigofera hirsutum	Fabaceae	Herb	17±1.85
Ipomoea triloba	Convulvulaceae	Herb	56±8.64
Laportea aestuans	Urticaceae	Herb	56±4.28
Lecaniodiscus cupanioides	Sapindaceae	Shrub	361±22.37
Leucaena leucocephala	Fabaceae	Tree	101±4.24
Mariscus flabelliformis	Cypreceae	Grass/Sedge	233±13.37
Morus mesozygia	Moraceae	Tree	24±1.77
Mucuna flagellipes	Fabaceae	Climbers	4±0.64
Mucuna pruriens	Fabaceae	Herb	251±13.32
Oldenlandia corymbosa	Rubiaceae	Herb	44±4.85
Oxalis curriculata	Oxalidaceae	Herb	75±4.33
Panicum maximum	Poaceae	Grass	45±4.11
Parquetina nigrescens	Asclepiadaceae	Shrub/Tree	102±7.62
Perperomia pellucida	Piperaceae	Herb	34±3.65
Physalis micranta	Solanaceae	Herb	85±7.16
Pupalia lappacea	Amaranthaceae	Shrub	200±16.02
Setaria barbuta	Poaceae	Grass	12±1.87
Sida acuta	Malvaceae	Shrub	35±5.79
Sida corymbosa	Malvaceae	Shrub	159±16.92
Solanum erianthum	Solanaceae	Shrub	254±14.30
Spigelia arthelmia	Loganiaceae	Herb	219±14.39
Talinum triagulare	Portulacaceae	Herb	334±18.03
Tridax procumbens	Asteraceae	Herb	237±13.61
Triumfetta cordifolia	Tiliaceae	Shrub	71±8.88

Table 2: Number of Individuals and Seasonal Composition of Woody Species that Emerged in the Seed Bank of the Twenty Four Study Plots

Tree species	April	June	Sept	Total
Albizia zygia	73	44	37	154
Alchornea cordifolia	37	41	19	97
Anogeissus leiocarpa	46	38	19	103
Antiaris toxicaria	53	37	29	119
Ficus capensis	41	52	17	110
Lecaniodiscus cupanioides	40	64	52	156
Leucaena leucocephala	27	48	26	101
Morus mesogygia	7	14	3	24
Total	**324**	**338**	**202**	**864**

Table 3: Simpson's Diversity Indices of the Seed bank Species composition of the Twenty-four Study Plots

Plots	No of Species	Individuals	Simpson Diversity
plot6	20	580	0.8961
plot8	26	552	0.9179
plot14	30	424	0.9282
plot17	21	253	0.9233
plot26	18	348	0.9128
plot28	17	296	0.824
plot30	17	240	0.9183
plot37	14	202	0.9037
plot41	19	279	0.8924
plot48	18	282	0.8754
plot49	17	259	0.8703
plot57	18	309	0.8895
plot60	15	255	0.8706
plot64	25	451	0.9078
plot69	14	447	0.8857
plot70	14	179	0.8734
plot76	18	408	0.8424
plot84	15	219	0.8462
plot89	24	280	0.9161
plot90	22	363	0.9219
plot95	16	290	0.8524
plot97	21	228	0.8961
plot68	31	459	0.9384
plot86	23	258	0.9293

Table 4: Simpson's Similariy Indices of the Seed bank Species composition of the Twenty-four Study Plots

	plot6	plot8	plot14	plot17	plot26	plot28	plot30	plot37	plot41	plot48	plot49	plot57	plot60	plot64	plot69	plot70	plot76	plot84	plot89	plot90
plot6	1																			
plot8	0.75	1																		
plot14	0.75	0.73	1																	
plot17	0.65	0.61	0.8	1																
plot26	0.56	0.61	**0.88**	0.66	1															
plot28	0.47	0.58	0.82	0.52	**0.35**	1														
plot30	**0.35**	0.58	0.58	0.41	0.41	**0.35**	1													
plot37	0.5	0.78	0.71	0.28	0.42	0.28	0.64	1												
plot41	0.47	0.68	0.58	0.36	0.5	0.29	**0.35**	0.71	1											
plot48	°0.66	**0.83**	0.66	0.38	0.44	0.29	0.47	0.57	0.55	1										
plot49	**0.35**	0.52	0.58	0.41	0.64	0.23	0.41	0.5	0.58	0.47	1									
plot57	0.61	0.72	0.72	0.38	0.55	0.29	0.35	0.57	0.66	0.55	0.47	1								
plot60	0.66	0.73	0.73	0.46	0.53	0.46	0.33	0.57	0.8	0.6	0.46	0.66	1							
plot64	0.7	0.56	0.72	0.57	0.66	0.52	0.64	**0.85**	0.68	0.77	0.64	0.72	0.86	1						
plot69	0.43	0.64	0.5	0.42	0.42	0.35	0.42	**0.35**	0.57	**0.35**	**0.36**	0.57	0.35	0.5	1					
plot70	0.43	0.57	**0.78**	0.64	0.57	0.5	**0.28**	0.21	0.57	**0.36**	0.42	0.64	0.57	0.57	**0.28**	1				
plot76	0.61	0.66	0.61	0.55	0.38	0.41	0.58	**0.35**	0.28	0.55	**0.35**	0.5	0.4	0.55	0.42	0.5	1			
plot84	0.8	0.8	0.8	0.66	0.53	0.33	0.53	0.5	0.53	0.6	**0.26**	0.6	0.53	0.8	0.42	**0.36**	0.66	1		
plot89	0.75	0.7	0.7	0.71	0.61	0.52	0.64	0.64	0.68	**0.77**	0.58	0.61	0.8	0.7	0.5	0.5	0.72	0.93	1	
plot90	0.65	0.59	0.68	0.61	0.72	0.47	0.52	0.5	0.52	0.5	0.65	0.55	0.66	0.68	0.5	0.64	0.55	0.6	0.72	1
plot95	**0.81**	**0.87**	0.75	0.68	0.56	0.5	0.56	0.5	0.5	0.62	0.44	0.5	0.6	0.81	0.42	**0.35**	0.63	0.66	0.93	0.93
plot97	0.5	0.66	0.66	0.38	0.66	**0.29**	0.47	0.5	0.47	0.66	0.59	0.61	0.6	0.57	0.5	0.42	0.55	0.6	0.61	0.61
plot68	0.7	0.69	0.66	0.71	0.61	0.7	0.76	0.71	0.68	0.72	0.76	0.61	0.73	0.72	0.71	0.64	0.66	0.73	0.75	0.68
plot86	**0.45**	0.47	0.52	0.38	0.44	0.47	0.41	0.35	0.52	0.38	0.59	0.61	0.4	0.47	0.5	0.64	0.5	0.4	0.39	0.54

This may result since they are easier to find, more nutritious than small seeds, and may be prone to predation in an impoverished seed environment (Stevenson 2007a).

It is predicted that in sites where forest productivity is higher and animal dispersers are abundant, regeneration rates will be faster since the seed bank and seed rain will be enriched, and shade tolerant seeds will be less limited by dispersal. Nevertheless, it is necessary to undertake other studies in different sites to evaluate and validate these predictions.

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