Report of the Restoration Permanent Sample Plots (PSPs) for 2018 at Nuluhon Trusmadi FR [1]

by

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Summary

Three (3) Permanent Sample Plots (PSPs) were set-up randomly in October, 2010 with the objectives to assess the survival rates and performance of the planted seedlings within the restoration areas at Apin-Apin, Nuluhon Trusmadi FR. The areas were rehabilitated a year earlier, in august of 2009. The plots were located as follows; - Plot 1 in Compartment 24, Plot 2 in Compartment 18 and Plot 3 in Compartment R15. An additional plot 4 was later set up in the project's subsequent new planting area at compartment R19. Compartment R19 was rehabilitated in august 2011 and the PSP or Plot 4 was set up in July 2013.

Each PSP is divided into three sub-plots to represent three slope-ranges in each PSP viz: - upper slope, middle slope and lower slope. Altogether, a total of 12 sub-plots were set-up in the 4 different PSPs. Each sub-plot consists of 150 planted points with seedlings planted at a distance of 3.5m along cleared planting rows and 10m between planting rows. In each Sub-plot there are 5 rows and each row contains 30 planting points. A PSP contains 450 planted points. The 4 PSPs contain a total of 1,800 planted points covering an area of 6.3 ha.

Latest assessment conducted in July, 2018 reveals an average survival rate of 36.7% for plot 1, 2 and 3 at the age of 108 months after planting. The survival rate breakdown by plots were; - 26.9% (plot 1), 44.2% (plot 2) and 38.9% (plot 3). However, plot 4 reveals a better survival rate of 70.4% at the age of 60 months after planting. So, taking the total average of the 4 plots regardless of age, the average survival of the 4 PSPs was about 45.1%. The survival rates of 45.1% translate to about 128 survive seedlings per hectare from an original planting density of about 285 seedlings per hectare. The lower sub-plots exhibit the highest mortality due to its location at the bottom slope which is exposed to mud-rolled and other land slide related natural calamity which adversely affected the seedlings.

Seraya Tembaga, Kapur and Uratmata seem to be the most robust species in terms of survival and height growth performance in the areas. Pioneer species such as Binuang have mostly died as the species probably need more open areas. Seraya Tembaga performs the best mean height growth followed by Kapur and Uratmata species. The detail information of the performance of the 4 plots is entailed in this report.

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(1.0) The PSPs and Locations

- Three (3) Permanent Sample Plots (PSPs) were set-up randomly in October, 2010 with the objectives to assess the survival rates and growth performance of the planted seedlings within the restoration areas at Apin-Apin, Nuluhon Trusmadi FR. The areas were rehabilitated a year earlier, in august of 2009. The plots were located as follows; - Plot 1 in Compartment 24, Plot 2 in Compartment 18 and Plot 3 in Compartment R15. Each PSP is divided into three sub-plots to represent three slope-ranges in each PSP viz: - upper slope, middle slope and lower slope. Altogether, a total of 9 sub-plots were set-up in the 3 different plots in 2010. An additional plot 4 was set up in the project's subsequent new planting areas at compartment R19. Compartment R19 was rehabilitated in august 2011 and the PSP or Plot 4 was set up in July 2013.

- Each sub-plot consists of 150 planted points with seedlings planted at a distance of 3.5m along cleared planting rows and 10m between planting rows. In each Sub-plot there are 5 rows and each row contains 30 planting points. With 4 sub-plots, a PSP contains 450 planted points. The 4 PSPs contain a total of 1,800 planted points covering an area of 6.3 ha. Locations of the 4 PSPs are as fig 1.

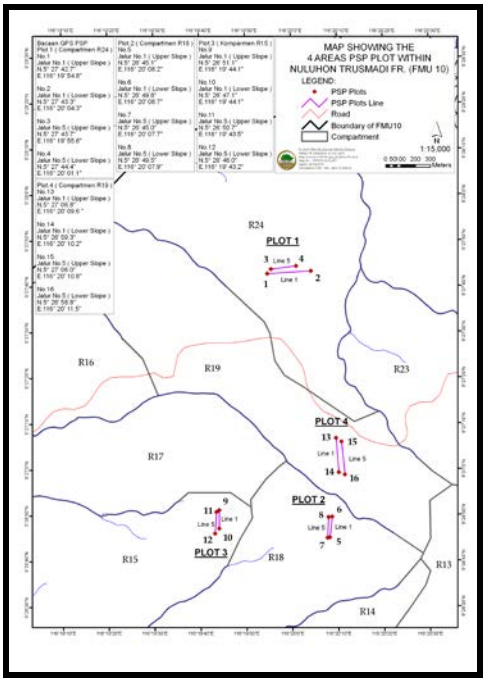


Fig 1: Locations of the 4 Restoration PSPs

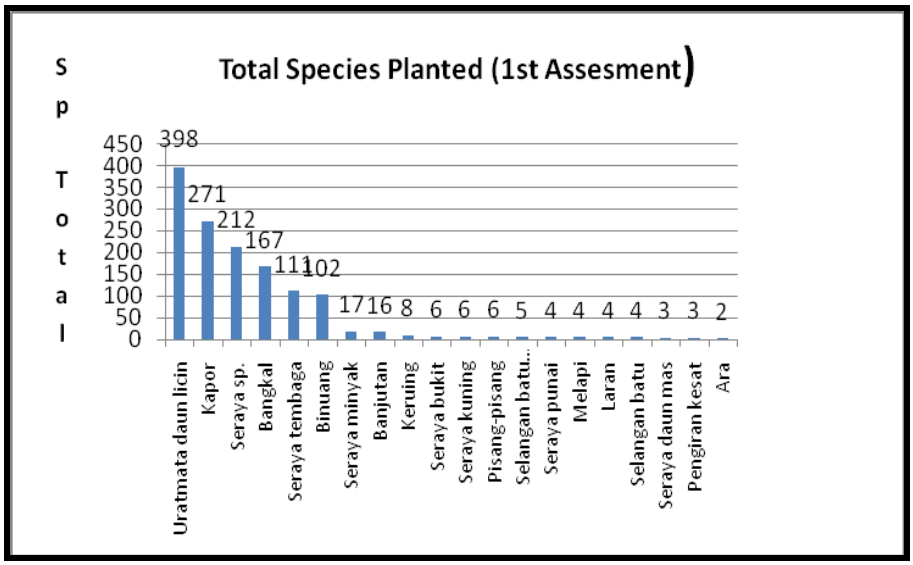
- Table 1 below shows the range and average gradient captured in the various plots and sub-plots. Plot 4 particularly the upper slope, is the most gentle sub-plot as compared to the other areas. The steepest are in Plot 3 particularly in the middle-slope at 36 degree gradient.

Table 1: Slope Gradient (degree) of the plots

	Upper Slope Degree		Middle Slope Degree		Lower Slope Degree	
	Range	Ave	Range	Ave	Range	Ave
Plot 1(R24)	13 – 36	20	2 – 23	12	4 – 8	6
Plot 2(R18)	20 – 29	25	23 – 26	19	24 – 28	26
Plot 3 (R 15)	14 – 35	28	30 – 40	36	14 – 26	20
Plot 4 (R 19)	0 - 6	4	8 - 31	17	21 - 34	28

(2.0) **Species Planted**

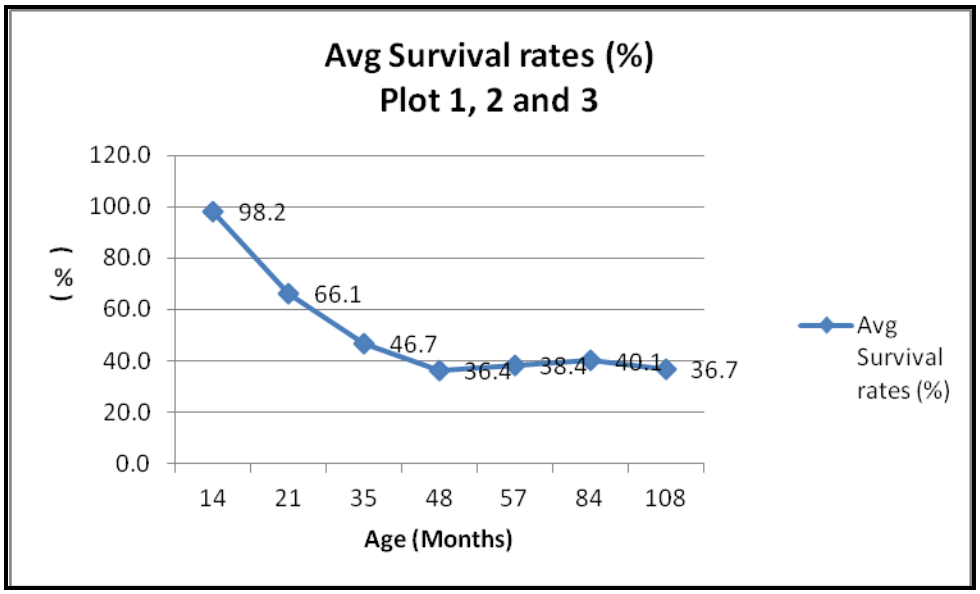
- Local indigenous species were planted in random in the restored areas. The following Graph 1 shows the various species planted in the first enumeration of the 3 PSPs (Plot 1, Plot 2 and Plot 3) during the setting up of the 3 plots. The main species planted were Uratmata, Seraya, kapur and Bangkal. Survival during the first enumeration (14 months after planting) was 98.2%. For Plot 4, the main species planted was mainly uratmata (>75%) and the rest was of the Seraya species.



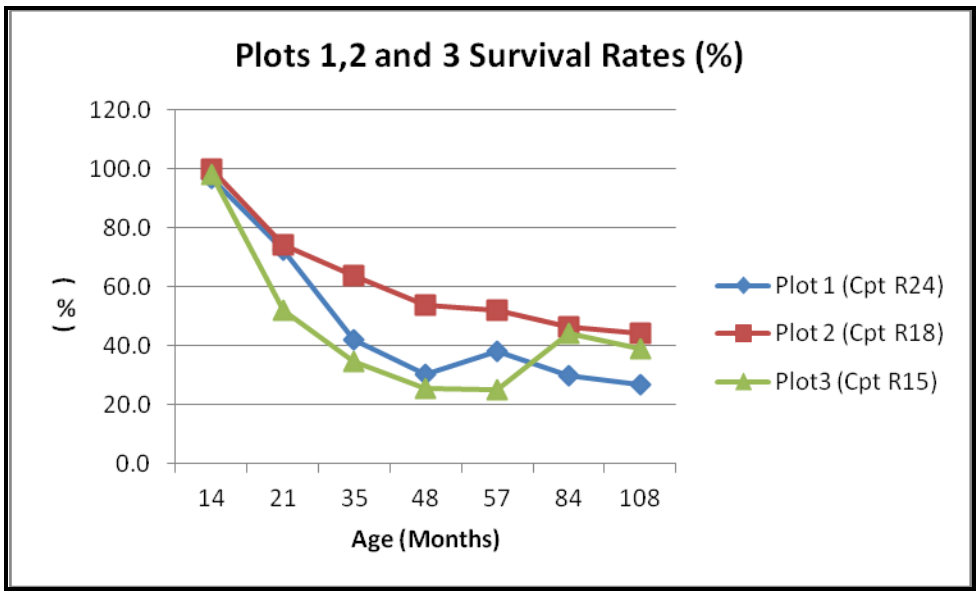
Graph 1: Summary of Species planted in Plot1, Plot2 and Plot3.

(3.0) Assessments and Survival Rates

- Since its inception, seven (7) assessments have been conducted for Plot 1, 2 and 3 and four (4) assessments for plot 4. The latest enumeration was conducted in July, 2018.
- The latest assessment reveals an average survival rate of 36.7% for plot 1, 2 and 3 at the age of 108 months after planting (Refer Graph 2). A mortality of about 3.4% since the last assessment about 2 years ago at 84 months. The survival rate breakdown by plots were; - 26.9% (plot 1), 44.2% (plot 2) and 38.9% (plot 3) (Refer Graph 3)). However, plot 4 reveals a better survival rate of 70.4% at the age of 84 months after planting. So, taking the total average of the 4 plots regardless of age, the average survival rate of the 4 PSPs was about 45.1%.
- Graft 3 shows an increase of Survival rates between assessments at age 48 and 84 months due to the replanting activities undertaken by FMU10 management team at plot 1 in mid 2012 and at plot 3 in late 2014. However, no replanting work was undertaken to plot 2. This explains why survival rates decreased steadily for plot 2 as depicted in graph 3.

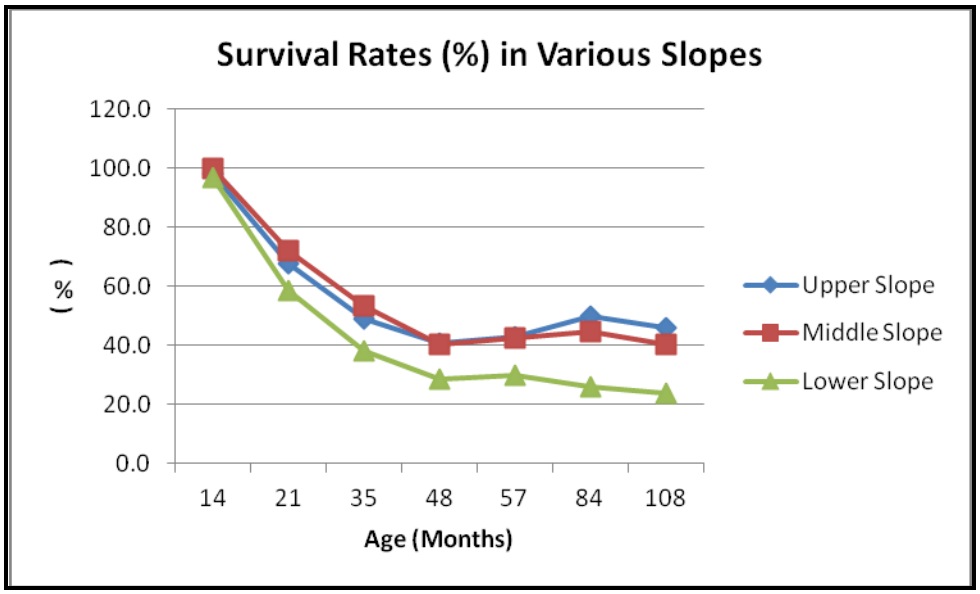


Graph 2: Average Survival Rates (%) of Plot 1,2 and 3.



Graph 3: Survival Rates (%) of Plot 1, 2 and 3

- The assessment also evaluates the effects of slope classes on survival of the planted seedlings. The lower slope was very vulnerable and exposed to soil erosion and sliding of woods debris down the slopes affecting planted seedlings. Survival rate was the lowest at the lower slope as compared to the other slopes (refer Graph 4). Latest Survival rates at the Upper Slope was 46%, Middle Slope at 40.4% and the Lower Slope was 36.7%.



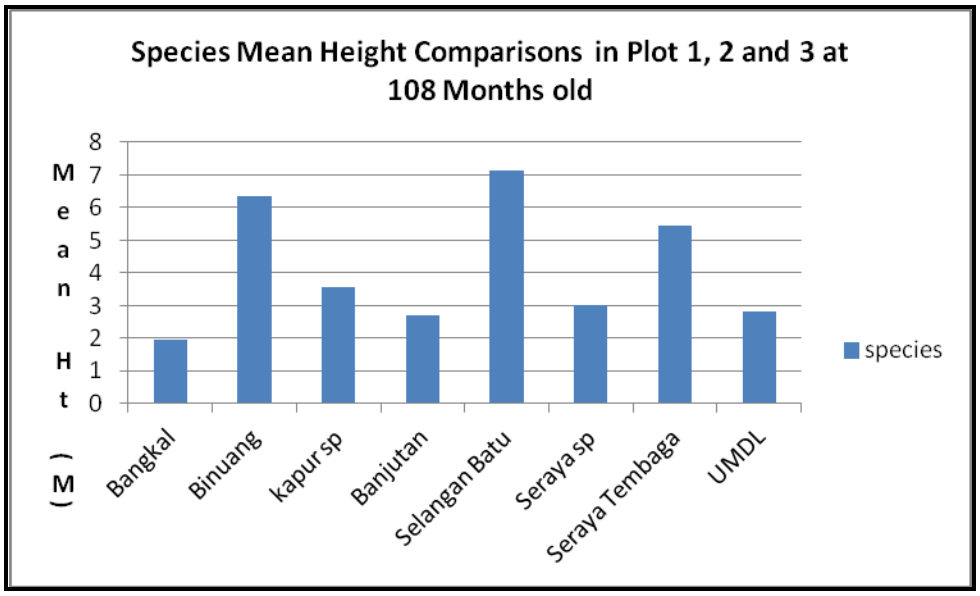
Graph 4: Survival Rates (%) on various slopes in Plot 1, 2 and 3

(4.0) The Growth Performance

(4.1) Overall Performance in Plot 1, 2 and 3

- The mean height of the species in plot 1, 2 and 3 is shown in Graph 5. Detail of the Height Data is summarised in Table 1. Table 2 shows that the range of height in the 3 plots was 0.2 to 13.4 metres tall at 108 months old. The low range of height (eg. 0.2m tall) for some seedlings were due to the re-growth of coppice from the stem of the planted seedlings. The old leaves have died off due to natural courses, and over time new coppices/shoots developed from these old stems. There were quite a number of plantlets measured were actually re-growth of coppice and these has resulted in the low mean height calculated of only about 3.29 metres tall for plot 1, 2 and 3. The maximum height of saplings in these 3 plots was 13.4 metres tall.

- Seraya Tembaga, Kapur sp (mainly kapur merah), other Seraya sp and UMDL (Uratmata Daun Licin) seems to be robust in terms of survival and growth. Seraya Tembaga growth to mean height of 5.46 metres tall after 108 months old as compared to 3.55 metres by Kapur sp.
- Selangan Batu and Binuang seems to show the highest mean height, but their number is low (<3), and thus not reflective of their true growth in the area. Most of these species have died off over the years.



Graph 5 : Mean Ht of various species in Plot 1, 2 and 3

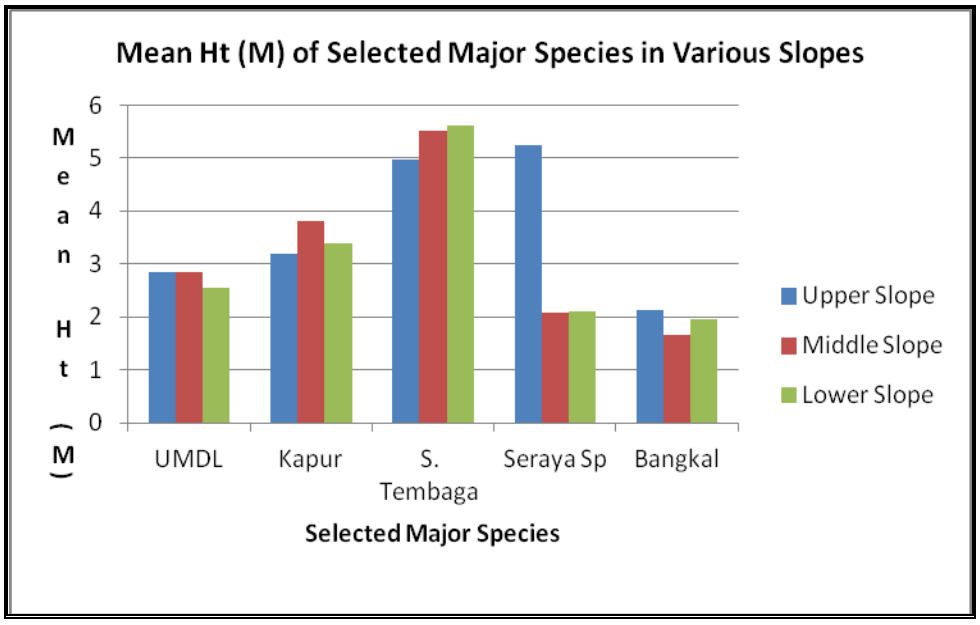
Table 2: Mean Height (M) of Plot 1, 2 and 3 at 108 Months Old

Mean Values		**Detail by species**			
Plot 1,2 and 3		**Species**	**N**	**Ht Range (M)**	**Mn Ht (M)**
Survival rates	37%	Bangkal	25	0.3 - 8.8	1.95
Ht Range (M)	0.2 - 13.4	Binuang	2	3.9 - 8.8	6.35
Mean Ht (M)	3.29	kapur sp	136	0.3 - 7.6	3.55
		Banjutan	1	2.7	2.7
		Selangan Batu	3	2 - 10.4	7.12
		Seraya sp	78	0.3 - 8.4	3.03
		Seraya Tembaga	41	0.7 - 11.7	5.46
		UMDL	203	0.2 - 13.4	2.83

- Another factor affecting growth performance and data capturing were due to “Broken Top” apart from the re-growth of coppice. The Uratmata species seems to be most vulnerable to “Broken Top” and we suspect that the species were not rigid enough to withstand strong winds that might occur in these hilly areas and also being in the slope.

(4.2) Growth Performance in Various Slopes of Plot 1,2 and 3

- Comparison of Mean Height of selected species in various slopes is illustrated in Graph 6 below and the detail data as in Table 3. It shows generally Seraya Tembaga seems to perform the best in the 3 slope classes, followed by Kapur and Uratmata Daun Licin.
- However, from Graph 6, the slope classes does not seems to reflect the expectation that the upper slope species growth performance is better than those at the lower slopes. This is probably due to the sites and species condition (eg. Land slide, canopy cover and re-growth of coppice and broken top).



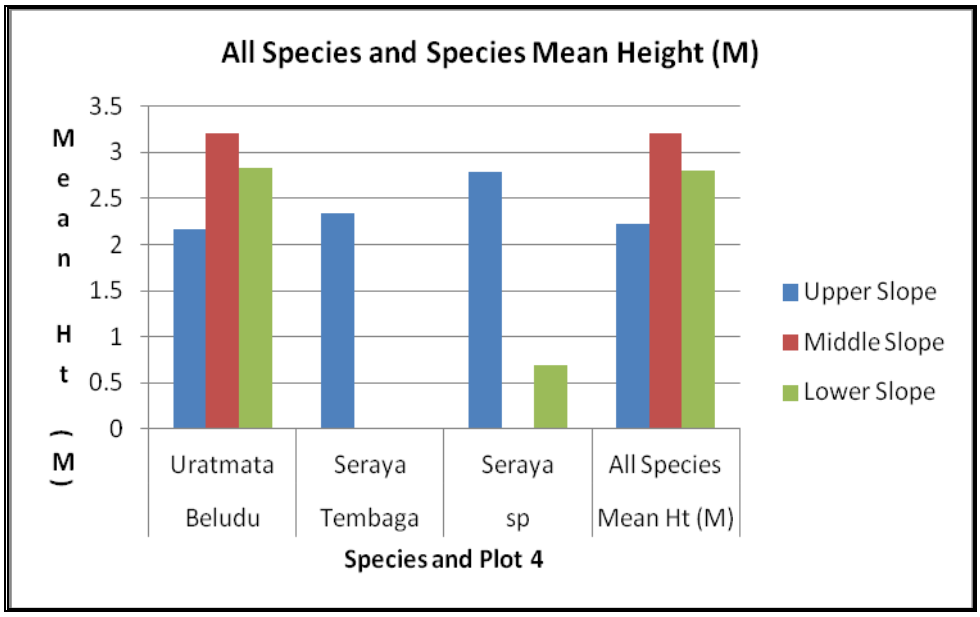
Graph 6: Mean Height (M) of Selected Major Species in Various Slopes of Plot 1, 2 and 3

Table 3: Mean Height (M) of Selected Species in Various Slopes of Plot 1, 2 and 3

Slope/sp	UMDL	Kapur	Seraya Tembaga	Seraya Sp	Bangkal
Upper Slope	2.85	3.20	4.98	5.24	2.12
Middle Slope	2.84	3.80	5.51	2.08	1.66
Lower Slope	2.56	3.4	5.61	2.1	1.95

(4.3) Plot 4

- Plot 4 was rehabilitated two (2) years after Plot 1, 2 and 3 in 2011. It was 84 months old when it was last assessed in July, 2018. Major species planted was Uratmata Beludu (>75%) and the rest were of the Seraya sp. During the last assessment, the survival rate for plot 4 was 70.4%. The survival rate in the various slope was; - 76.6% (upper slope), 76% (middle slope) and 58.7% for the lower slope.
- Comparison of mean height of the species in the entire slope classes as well as in the various slope are as shown in Graph 7. The detail data in terms of Mean Height, number of surviving seedlings and the range of height of the seedlings are illustrated in table 4.



Graph 7: Mean Ht of Species in Plot 4 at age 84 Months old

- The graph shows that growth in height of the planted seedlings is high in the middle slope. It also shows that most mortality of planted seedlings in this plot occurs in the lower slope with a survival rate of 58.7 % as compared to the higher slope with higher survival rate of more than 75%.

Table 4: Mean Height (M) of Species in Plot 4

Mean Height (M)				
Slope/Species	**Uratmata Beludu**	**Seraya Tembaga**	**Seraya Sp**	**Mean Ht (M) All Species**
Upper Slope	2.16	2.33	2.78	2.22
Middle Slope	3.2	0	0	3.2
Lower Slope	2.83	0	0.69	2.8
	N= No. sp R= Ht (M) Range			
Upper Slope	N=102 R=0.3 - 6.8 m	N=3 R=1.1 - 3.1m	N=10 R=0.6 - 5.4m	N= 115 R=0.3 - 6.8 m
Middle Slope	N=114 R= 0.6 - 9 m	0 0	0 0	N=114 R= 0.6 - 9 m
Lower Slope	N=87 R=0.3 -8.2 m	0 0	N=1 R=0.7	N=88 R=0.3 - 8.2 m

Note : (1) N= Number (2) R= Range of Height

(5.0) General Discussion

- The average survival rates of the 4 PSPs covering a total area of about 6.3 ha with age (plot 1,2 and 3 at 108 months old and plot 4 at 84 months old) was 45.1%. Survival rates of Plot 1, 2 and 3 at 108 months old was 36.7%, whilst that for plot 4 at 84 months was 70.4%.
- The survival rate of 45.1% translate to about 128 survive seedlings per hectare from an original planting density of about 285 seedlings per hectare regardless of age of the seedlings.
- The lower sub-plots suffer highest mortality due to its location at the bottom slope which is exposed to soil erosion and woods debris sliding down the slopes affecting adversely the seedlings planted.

- The steep terrain of the rehabilitated sites with mostly at least 20 degrees slope provide the biggest challenge during planting and in the subsequent monitoring and maintenance activities. The steeper the slope the higher occurrences of land slide anticipated and hence the survival of planted seedlings.
- Seraya Tembaga, Kapur, Uratmata and other Seraya species seems to be adaptable in this environment. Their survival and height growth are acceptable in these harsh conditions. However, Seraya Tembaga performs the best in terms of mean height growth, followed by Kapur and Uratmata species.
- It was observed in the last assessment; “broken-top” affected about 50% of the Uratmata species. This problem was not obvious to the other species. This might have affected the height growth measurements of the Uratmata species. The reasons are probably the species young stem are soft and more vulnerable to strong wind which is common in the areas.
- It is obvious that pioneer species such as Binuang could not withstand the competition environment of this area due to the canopy cover that still persist in most of this restoration sites.
- Generally, the 4 PSPs still needs maintenance particularly eradicating climbing creepers and line weeding annually to ensure the remaining seedlings will continue to survive, grow and enrich the areas.

Sept, 2018.