
Progress Report IV

1. Services availed from Dungmin Community Forest (CF)

Only 10 % of the Community Forest Management Group (CFMG) households have availed the services from the CF since after inception in 2013. The most required services for domestic use was fuel wood (65% households), however villager does not depend much on CF for firewood collection. CFMG has not yet harvested the timber although the CF has the potential for timber production. The extrapolated economic value of CF is estimated around Nu. 1.75 million (USD 27,040) annually.

2. Community forest assessment for ecosystem services

The tree distribution in the community is normal and showing equal numerical strength. The most numerically dominating trees are *Pterospermum acerifolium* (Relative density 9.97%) and *Szygium cuminii* (Relative density 6.98%). These two species have timber value and shows higher timber production in future. The CF has Shannon-Weiner diversity index of 3.61 and Simpson diversity index of 27. Timber species having highest Total Basal Area (TBA) are *Tetrameles nudiflora* and *Dubanga grandiflora* with 43.5 ft.² and 31.4 ft.² respectively in the entire CF. Ruankiaer's frequency distribution showed almost homogenous distribution of species as shown by distribution equation; $36 > 9 > 5 \neq 3 > 0$. This indicate the community is in seral stage to climax stage. The distribution equation also tells about least disturbance of community forest and with balanced distribution of floral species. This has supported the wildlife such as *Elephas maxima*, *Bos gaurus*, *Muntiacus muntjak* etc.

3. Stream discharge quantities

The field work was carried out in the month June during the onset of monsoon and volume of water discharge may be overestimated. The stream gauging was done together with Dangling CF. The estimated flow rate of stream is 61.7 ft³/sec is drained out from two CFs.

4. Priority ranking of NTFP

The CFMG focuses on timber production and NTFPs collection were not the priority. The CFMG has only collected 179 bundles of *Thysanolaena maxima* which is worth of Nu. 4,475 (USD 68) excluding the opportunity cost of labor. The ranking was not obtained as *Thysanolaena maxima* is only prioritized NTFP by the villagers.

Table.1. Vegetation analysis of CF and timber species showing the quantitative characteristics

Name of the species	R.density	R. Freque.	Abundance	H'	Ds	Dmg	Raunkiaers fre.dist.
<i>Dunbaga grandiflora</i>	1.74	2.11	2.10	-0.07		18.07	
Mela (Local Name)	5.15	4.43	2.95	-0.15		13.33	
Aumbeckey (Local Name)	1.08	1.27	2.17	-0.05		21.44	
<i>Sapium baccatum</i>	2.66	3.59	1.88	-0.10		15.87	
<i>Rhus griffithii</i>	0.66	0.84	2.00	-0.03		26.45	
<i>Ostodes paniculatus</i>	4.32	4.01	2.74	-0.14		13.92	
<i>Pterospermum acerifolium</i>	9.97	6.33	4.00	-0.23		11.49	
Tortola (Local Name)	0.25	0.42	1.50	-0.01		50.06	
<i>Syzygium cuminii</i>	6.98	5.27	3.36	-0.19		12.41	
<i>Michelia champaca</i>	2.91	2.95	2.50	-0.10		15.47	
<i>Terminalia myriocarpa</i>	7.14	5.49	3.31	-0.19		12.35	36>9>5#3 >0
<i>Polyathia simiarum</i>	1.08	1.27	2.17	-0.05	27.00	21.44	
<i>Ailanthus grandis</i>	1.50	1.48	2.57	-0.06		19.03	
<i>Aphanamixis polystachya</i>	1.83	2.11	2.20	-0.07		17.79	
<i>Tetrameles nudiflora</i>	1.74	2.32	1.91	-0.07		18.07	
<i>Pterospermum acerifolium</i>	1.16	1.27	2.33	-0.05		20.84	
<i>Beilschmiedia s</i>	3.41	3.80	2.28	-0.12		14.81	
<i>Ostodes paniculatus</i>	2.57	2.95	2.21	-0.09		16.02	
<i>Syzygium sp.</i>	1.16	1.48	2.00	-0.05		20.84	
<i>Toona ciliata</i>	2.08	2.53	2.08	-0.08		17.09	
<i>Sterculia villosa</i>	0.50	0.63	2.00	-0.03		30.70	
Goprey (Local Name)	0.50	0.42	3.00	-0.03		30.70	
<i>Aphanamixis polystachya</i>	3.41	3.38	2.56	-0.12		14.81	
<i>Schima wallichii</i>	2.16	2.74	2.00	-0.08		16.88	
<i>Terminalia chebula</i>	0.50	0.63	2.00	-0.03		30.70	
Kadam (Local Name)	0.42	0.42	2.50	-0.02		34.17	

Table.2. Timber Volume (Measured only timber with sizable girth i.e. circumference >3ft.)

Si. No.	Species	Total Basal Area (Ft. ²) in sampled area.
1	Mela (Local Name)	8.54
2	<i>Szygium cumunii</i>	9.69
3	<i>Tertrames nudiflora</i>	43.50
4	<i>Pterospermum acerfolium</i>	9.65
5	<i>Michelia champaca</i>	20.17
6	<i>Castanopsis hystrix</i>	9.29
7	Kali kat (Local Name)	9.10
8	<i>Toona ciliata</i>	12.52
9	Lal muntey (Local Name)	0.92
10	<i>Mangifera indica</i>	6.90
11	Aumbeckey (Local Name)	2.63
12	<i>Dunbanga grandiflora</i>	31.48
13	<i>Ostodes paniculata</i>	10.13
14	Darim patey (Local Name)	3.06
15	<i>Schima wallichii</i>	18.12
16	<i>Beilschmiedia sp.</i>	22.01
17	<i>Cinnamomum glanduferum</i>	5.23
18	Balu kat (Local Name)	1.40
19	<i>Bridila sp.</i>	6.83
20	Goprey (Local Name)	1.27
21	Sheti (Local Name)	28.44

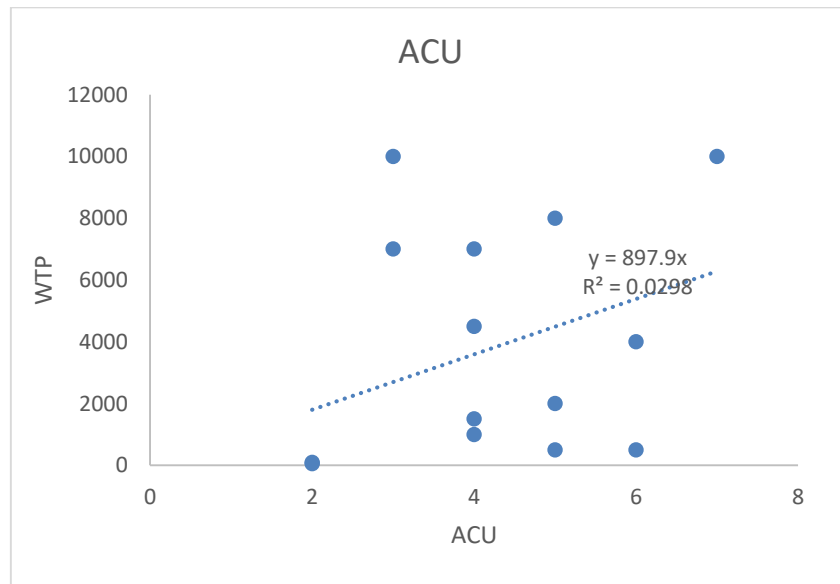
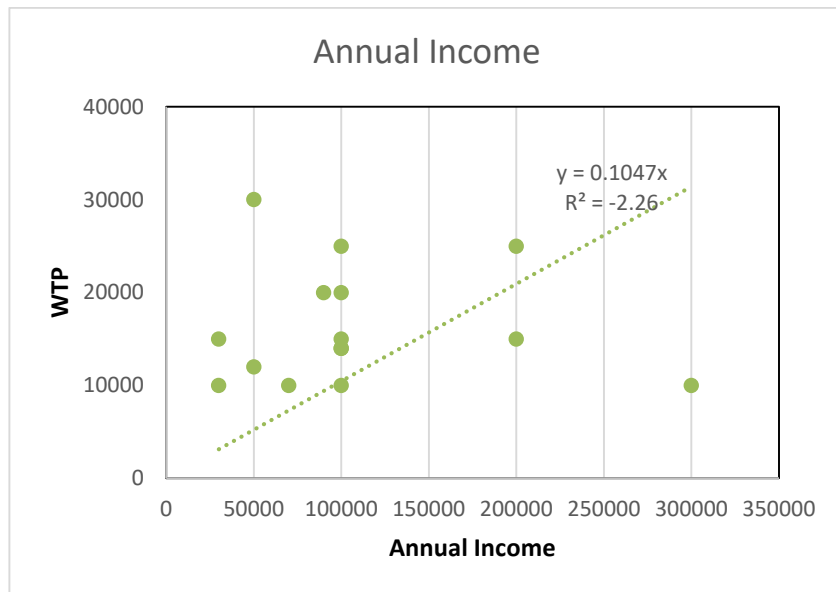
Table.3. Stream discharge quantity measurements

Quantity of stream discharge for irrigation						
Length of stream	Width (mean)	Depth (mean)	Area	Time taken (mean)	Velocity (mean)	Water Discharge
164 ft.	6.83 ft.	3.55 ft.	24.24 ft. ²	54.6 sec.	2.5ft./sec.	61.7 ft ³ /sec.

Table.4. Economic valuation of Non-Consumptive Use values (Sampled value)

Economic valuation of non-consumptive use values							
Total households	Total ACU	Total Land holding size	Total Annual Income	Education status	Env. Awareness	Grand Total WTP	Extrapolated WTP (Nu.)
15	79	71 acres	1400000	NFE and illiterate	High	507000	1.75 millions

ACU: Adult Cattle Unit, WTP: Willingness to Pay.



1. Services availed from Lingar Community Forest (CF)

Community Forest Management Group (CFMG) households have not availed the services from the CF since after inception in 2012. The CF is dominated by *Acacia catechu* (local name; Khair) which is used for medicinal purposes. The villagers have not collected the any provisioning services, however the CF provides significant regulating services such as flood and soil erosion prevention by maintaining the river course. The extrapolated economic value of CF is estimated around Nu. 1.345 million (USD 27,040) annually.

2. Community forest assessment for ecosystem services

Only 30 trees species are found in the CF and distribution in the community is dominated numerically by *Acacia catechu* and *Gmelia arborea* with relative density 5.5% and 2.10% respectively. *Acacia catechu* grows in barren land having low moisture and nutrients as it has root noodle for nitrogen fixation. *Sterculia villosa*, *Albizia procera* and *Ficus roxburghii* are grown sparsely and lesser in number (relative density; 0.10%). The CF has Shannon-Weiner diversity index of 2.58 and Simpson diversity index of 6.59. Timber species having highest Total Basal Area (TBA) are *Tetrameles nudiflora* and *Dubanga grandiflora* with 41.2 ft.² and 32.426 ft.² respectively in the entire CF. Ruankiaer's frequency distribution showed almost heterogeneous distribution of species as shown by distribution equation; $23 > 7 > 0 \neq 1 > 0$.

3. Stream discharge quantities

The field work was carried out in the month of July during the onset of monsoon and volume of water discharge may be overestimated. The estimated flow rate of stream is 6.32 ft³/sec. The water draining out from CF is used for Paddy cultivation in summer and in winter for vegetable cultivation. The water is also used for drinking purposes.

4. Priority ranking of NTFP

Although CF has potential to harvest the barks of *Acacia catechu*, The CFMG has not yet harvested due to the lack of market and very marginal price for the bark. The villagers have not yet generated any income from the CF since from establishment. For future income generation, the villagers have started planting the sapling of timber species such as *Tectona grandis* and *Michelia champaca*.

Table.1. Vegetation analysis of CF and timber species showing the quantitative characteristics

Name of the species	R. D (%)	R.F (%)	Abundance	H'	Ds	Ruankiaer's fre. dist.
<i>Gmelia arborea</i>	12.84	6.80	6	-0.26		
<i>Dalbergia sissoo</i>	2.75	4.85	1.80	-0.10		
<i>Ailanthus grandis</i>	8.26	4.85	5.40	-0.21		
<i>Alstonia scholaris</i>	1.22	2.91	1.33	-0.05		
<i>Dubanga grandiflora</i>	0.61	0.97	2	-0.03		
<i>Tertrames nudiflora</i>	1.53	2.91	1.67	-0.06	6.48	23>7>0≠1>0
<i>Bombax ceiba</i>	1.22	2.91	1.33	-0.05		
<i>Tectona grandis</i>	4.59	1.94	7.50	-0.14		
<i>Schima wallichii</i>	0.61	1.94	1	-0.03		
<i>Michelia champaca</i>	2.45	1.94	4	-0.09		
<i>Terminalia myriocarpa</i>	0.92	0.97	3	-0.04		

Table.2. Timber Volume (Measured only timber with sizable girth i.e. circumference >3ft.)

Si. No.	Species	Total Basal Area (Ft. ²) in sampled area.
1	<i>Dubanga grandiflora</i>	32.426
2	<i>Tertrames nudiflora</i>	41.125
3	<i>Ailanthus grandis</i>	7.892
4	<i>Gmelia arborea</i>	12.33
5	<i>Bombax ceiba</i>	10.13
6	<i>Schima wallichii</i>	6.78

Table.3. Stream discharge quantity measurements

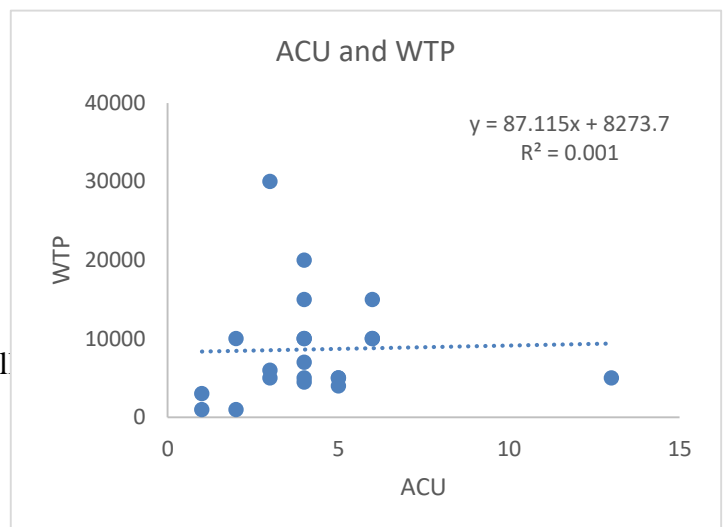
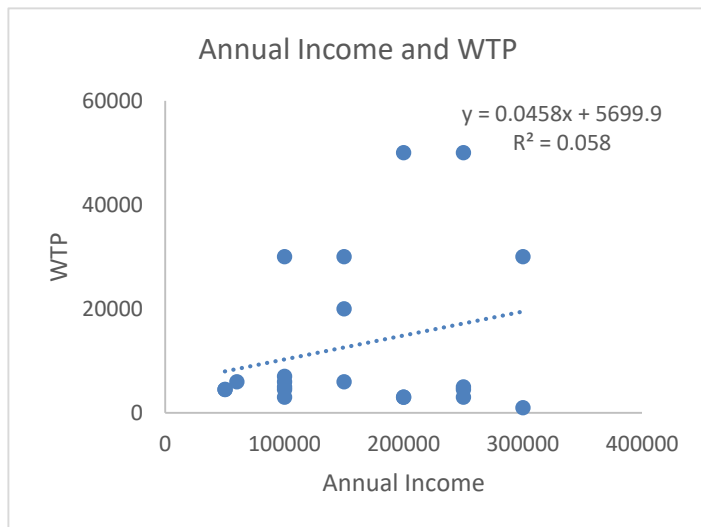
Quantity of stream discharge for irrigation						
Length of stream	Width (mean)	Depth (mean)	Area	Time taken (mean)	Velocity (mean)	Water Discharge
164ft.	6.39ft.	0.49ft.	3.13ft. ²	69 Sec.	2.02 ft./sec.	6.32 ft ³ /sec.

Table.4. Economic valuation of Non-Consumptive Use values (Sampled value)

Economic valuation of non-consumptive use values							
Total households	Total ACU	Total Land holding size	Total Annual Income (Nu.)	Education status	Env. Awareness	Grand Total WTP (Nu.)	Extrapolated WTP (Nu.)
22	89	acres	3,410,000	NFE and illiterate	High	846,000	1.345 million

ACU: Adult Cattle Unit, WTP: Willingness to Pay.

1 USD= Nu. 65.4





1. Services availed from Gaden Community Forest (CF)

Gaden Community Forest lies adjacent to Linger CF and the physiognomy shows similar vegetation cover. Gaden Community Forest Management Group (CFMG) has started to manage the CF for production of timber and NTFP. Similar to Linger CF, the Gaden CF provides significant regulating services such as flood prevention and soil erosion by maintaining the river course. The CF is primarily used as pasture for grazing and positive relationship is found between willingness to pay (WTP) adult cattle unit (ACU). The extrapolated economic value of CF is estimated around Nu. 1.89 million (USD 29,076) annually.

2. Community forest assessment for ecosystem services

The tree distribution in the community is dominated numerically by *Acacia catechu* and *Zizipus jujuba* with relative density 43% and 13% respectively. Both trees have higher survival on barren land having low moisture and nutrients. Trees species such as *Sterculia villosa*, *Streaspermum suaveolens*, *Terminalia arborea*, *Bombax ceiba* and *Gmelia arborea* and *Ficus roxburghii* have equal dominance over the community. The CF has Shannon-Weiner diversity index of 1.95 and Simpson diversity index of 4.48. Ruankiaer's frequency distribution showed almost heterogeneous distribution of species as shown by distribution equation; $8 > 3 > 0 \neq 1 > 0$. The CF has been mostly set fire intentionally for grazing which adversely affects the growth of other trees.

3. Stream discharge quantities

The CF does not provide water services and water that drains out are perishable for week to month. Therefore the stream discharge quantity was not measured prior to lack of water services.

4. Priority ranking of NTFP

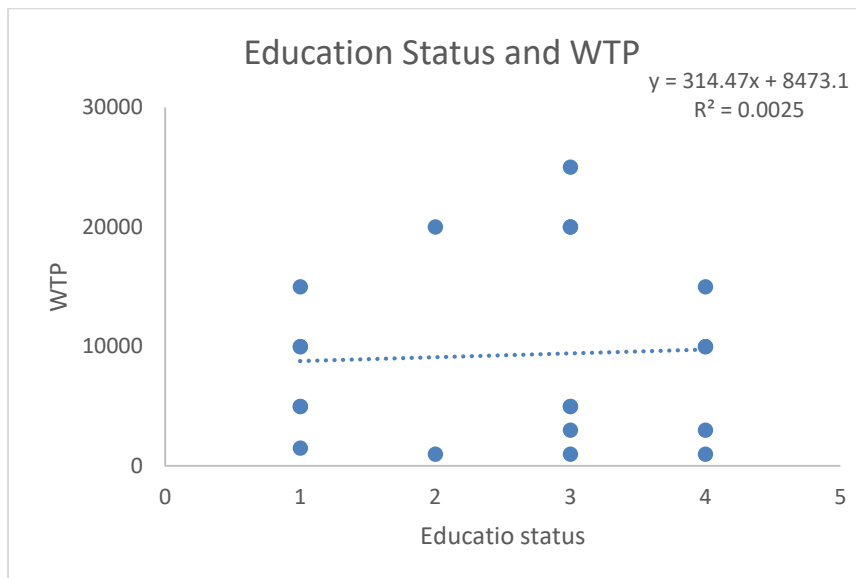
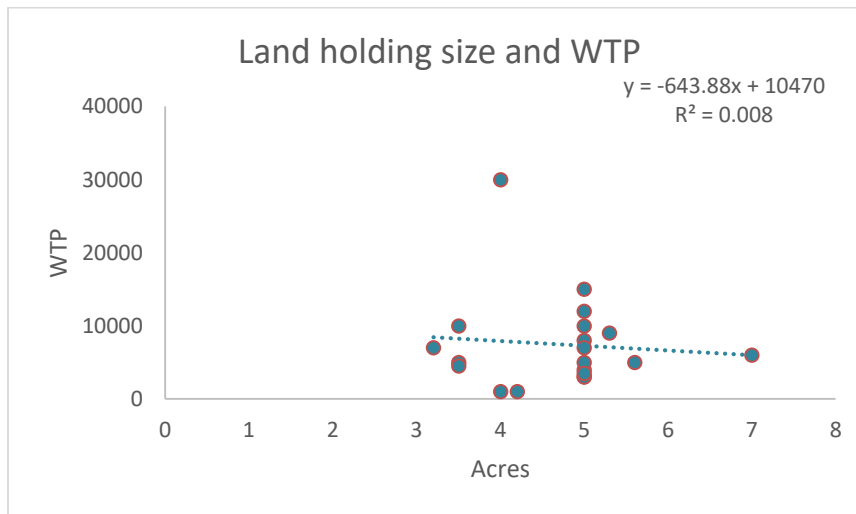
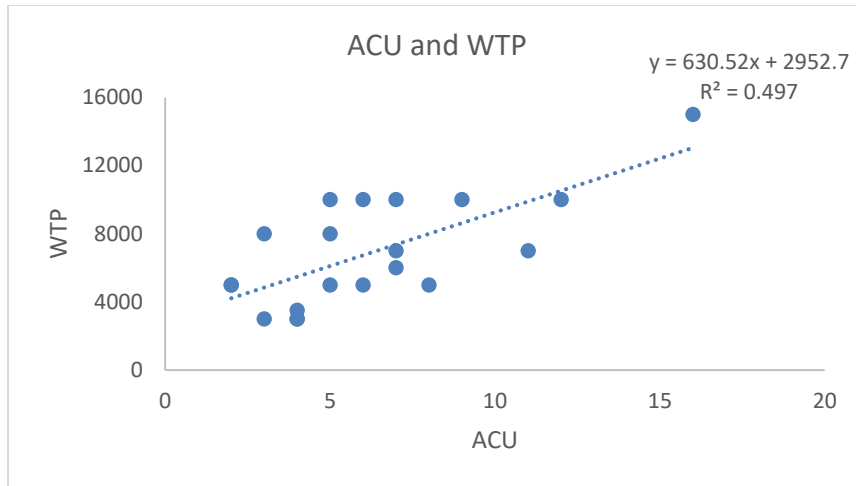
Similar to Linger CF, the CF has potential to harvest barks of *Acacia catechu* besides no other NTFP are harvested. Fruits of *Zizipus jujuba* are sometime collected for local consumption and villager does not give importance on commercial aspects. Prior to these reason, priority ranking of NTFP was not obtained.

Table.1. Vegetation analysis of tress with NTFP and Timber value

Name of the species	R. D (%)	R.F (%)	Abundance	H'	Ds	Ruankiaer's fre. dist.
NTFP						
<i>Acacia catechu</i>	43	25.32	4.70	-0.36		
<i>Zizipus jujuba</i>	13	12.66	2.80	-0.26		
<i>Streaspermum suaveolens</i>	2	3.80	1.33	-0.27		
<i>Sterculia villosa</i>	2	2.53	2.50	-0.09		
Timber					1.95	8>3>0≠1>0
<i>Dubanga grandiflora</i>	6	6.33	2.40	-0.16		
<i>Bombax ceiba</i>	6	10.13	1.63	-0.17		
<i>Gmelia arborea</i>	2	3.80	1.67	-0.09		
<i>Toona ciliata</i>	4	5.06	2	-0.12		

Table.2. Economic valuation of Non-Consumptive Use Value

Economic valuation of non-consumptive use values							
Total households	Total ACU	Total Land holding size	Total Annual Income (Nu.)	Education status	Env. Awareness	Grand Total WTP (Nu.)	Extrapolated WTP
20	126	93.8 acres	2,250,000	NFE and illiterate	High	1,050,000	1.89 millions
ACU: Adult Cattle Unit, WTP: Willingness to Pay.							



1: Illiterate, 2: primary, 3: NFE, 4: Higher Secondary



1. Services availed from Rijug Community Forest (CF)

Similar to Gaden and Linger CF, Community Forest Management Group (CFMG) of Rijug CF has not availed the services from the CF since after the inception in 2012. The CF is largely destroyed by severe monsoon flood and ecological restoration is mandatory for continual ecosystem services delivery. Only 18 tree species grows in the CF and the CF dominated by *Streaspermum suaveolens* and *Ailianthus grandis*. The villagers have not collected the NTFP, however the CF provides significant regulating services such as flood prevention and soil erosion by maintaining the river course. The villagers have planted seedlings of *Michelia champaca* and *Tectona grandis* for future timber production. The economic value of CF is least of all the CFs under the project, which is estimated around Nu. 1.34 million (USD 20,676) annually.

2. Community forest assessment for ecosystem services.

The community forest has poor productivity of timber and NTFP showing least density of species of economic importance. *Streaspermum suaveolens* and *Ailianthus grandis* have higher numerical strength with relative density of 10.95% respectively. The least *Terminalia bellerica* and *Litsea scilifolia* has least in number showing the weaker competition in the CF. The CF has Shannon-Weiner diversity index of 2.75 and Simpson diversity index of 14.79. The CF has no timber harvesting potential because only two timber species viz. *Dubanga grandiflora* and *Gmelia arborea* grows in the CF with weaker numerical strength. Ruankiaer's frequency distribution showed almost heterogeneous distribution of species with disturbed ecology as shown by distribution equation; $14 > 3 > 0 \neq 0 > 0$.

3. Stream discharge quantities.

The field work was carried out in the month August during the monsoon season and volume of water discharge may be overestimated. The estimated flow rate of stream is 0.22 ft.³/min. The water draining out from CF is exclusively used for drinking purposes.

4. Priority ranking of NTFP.

The raking of NTFP was not obtained because CF does not have potential to provide NTFPs in adequate quantities and villagers have not yet generated any income from the CF since from establishment.

Table.1. Vegetation analysis of tress (timber value) with and NTFP

Name of the species	R. D (%)	R.F (%)	Abundance	H'	Ds	Raunkiaer's fre. dist.
NTFP						
<i>Sterculia villosa</i>	3.98	5.68	1.60	-0.13		
<i>Ficus hispida</i>	4.48	4.55	2.50	-0.15		
<i>Streaspermum suaveolens</i>	10.95	10.23	2.49	-0.24		A>B>C≠D<E
Timber						
<i>Tetrameles nudiflora</i>	4.98	7.95	1.43	-0.15	14.7	14>3>0≠0>0
<i>Dubanga grandiflora</i>	4.48	4.55	2.25	-0.14		
<i>Gmelia arborea</i>	2.99	5.68	3.09	-0.10		

Table.2. Quantity for stream discharge for drinking water

Length	Breadth	Height	Total volume	Time	New height	Volume of water added	Per minute discharge
1.5 ft.	2 ft.	2.3 ft.	6.9 ft. ³	30 min.	4.2 ft.	6.6 ft. ³	0.22 ft. ³ /min.

Table.3. Economic valuation of Non-Consumptive Use Value

Economic valuation of non-consumptive use values							
Total households	Total ACU	Total Land holding size	Total Annual Income (Nu.)	Education status	Env. Awareness	Grand Total WTP (Nu.)	Extrapolated WTP (Nu.)
20	56	153.6 acres	1550,000	NFE and illiterate	High	896,000	1.34 millions

ACU: Adult Cattle Unit, WTP: Willingness to Pay.

1. Services availed from Juenphen Community Forest (CF)

Tareythang CF grows less species having economic importance and the physiognomy of the forest shows *Schima wallichii* dominance. The Community Forest Management Group (CFMG) has not availed services since its inception on 2014. The CF has 39 different tree species with some species having timber value. The CFMG plans manage forest for bamboo production besides timber and brooms. The CF provides drinking water to the villager and relies on it without other water sources. The NTFP collected were *Thysanolaena maxima* and *Piper nigrum* worth of Nu. 61,500 (USD 946.15) from the date of CF establishment. The economic value of CF is estimated around Nu. 1.036 million (USD 15,938.4) annually.

2. Community forest assessment for ecosystem services.

The community forest has poor productivity of timber as most trees are not harvestable (circumference is <3ft.). *Schima wallichii* has highest numerical strength with relative density of 33.6%. Other species such as *Tectona grandis*, *Albizia procera* and *Szygium cuminii* have relatively equal numerical strength with relative density of 6.6%, 4.4% and 4.6% respectively. The species showing weaker competition in community are *Photinia integrifolia*, *Castanopsis hystrix*, *Bombax ceiba* and *Gmelia arborea*. The CF has Shannon-Weiner diversity index of 2.76 and Simpson diversity index of 7.44. Ruankiaer's frequency distribution showed heterogeneous distribution of species with disturbed ecology as shown by distribution equation; $26 > 9 > 3 \neq 0 < 1$

3. Stream discharge quantities.

The estimated flow rate of stream is 0.61 ft³/min. The water draining out from CF is exclusively used for drinking water.

4. Priority ranking of NTFP.

The CF provides NTFPs; *Thysanolaena maxima* and *Piper nigrum*. The villagers have not yet generated any income from the CF since from establishment. For future income generation, the villagers have started managing forest for NTFP production. Therefore due to irregular collection and minimal harvest of NTFP, the raking was not obtained.

Table.1. Vegetation analysis of tress having timber value

Name of the species	R. D (%)	R.F (%)	Abundance	H'	Ds	Raunkiaer's fre. dist.
<i>Schima wallichii</i>	33.6	14.07	7.3	-0.37		
<i>Michelia champaca</i>	4.4	3.52	3.9	-0.14		
<i>Tectona grandis</i>	6.6	4.02	5.0	-0.18		
<i>Gmelia arborea</i>	1.0	1.01	3.0	-0.05		
<i>Szygium cuminii</i>	4.6	6.53	2.2	-0.14		
<i>Castanopsis hystrix</i>	0.2	0.50	1.0	-0.01	7.44	26>9>3≠0<1
<i>Bombax ceiba</i>	1.8	3.52	1.6	-0.07		
<i>Aphanamixis polystachya</i>	0.3	0.65	2.0	-0.02		
<i>Mallotus philippensis</i>	0.3	0.50	2.2	-0.04		
<i>Helicia nilagirica</i>	2.5	3.52	2.1	-0.31		

Table.2. Stream discharge quantity measurements

Length	Breadth	Height	Total volume	Time	New height	Volume of water added	Per minute discharge
2.5 ft.	2 ft.	2.5 ft.	12.5 ft. ³	30 min.	6.2 ft.	18.5 ft. ³	0.61 ft. ³ /min.

Table.3. Economic valuation of Non-Consumptive Use Value

Economic valuation of non-consumptive use values							
Total households	Total ACU	Total Land holding size	Total Annual Income (Nu.)	Education status	Env. Awareness	Grand Total WTP (Nu.)	Extrapolated WTP (Nu.)
20	62	163.4 acres	1230,000	NFE and illiterate	High	74,0000	1.036 million

ACU: Adult Cattle Unit, WTP: Willingness to Pay.

1. Services availed from Chakgari Community Forest (CF)

The community forest has timber production potential however most of the tree were not harvested for commercial production due to lack of management plan and silviculture practices. The Community Forest Management Group (CFMG) availed services very less due to availability of forest products in state forest. The CFMG has collected *Bambusa nutans* and *Thysanolaena maxima* income generation. The CF does not provide drinking water services however serve as catchment area for watershed. The total income generated from collecting the NTFP was Ngultrum 2800 (USD 43.07) from the date of CF establishment. The economic value of CF is estimated around Nu. 1.65 million (USD 25401.92) annually.

2. Community forest assessment for ecosystem services

The physiognomy of the forest shows *Schima wallichii* dominance, however the forest community has 56 tree species growing in it with maximum tree species having timber value. *Schima wallichii* and *Ostodes paniculatus* has highest numerical strength with relative density of 33.6% and 21%. Other timber species such as *Ailanthus grandis*, *Symplocos* sp., *Phoebe lanceolata*, and *Szygium cuminii* have relatively equal numerical strength showing equal dominance in number. The tree species showing weaker competition in the community are *Talauma hodgsoni*, *Albizia procera* and Dudev Nibara (Local Name). The CF has Shannon-Weiner diversity index of 3.71 and Simpson diversity index of 35.74 showing higher diversity of tree species. Ruankiaer's frequency distribution showed almost normal distribution of species without much disturbances in ecology as shown by distribution equation; $16 < 33 > 7 \neq 0 > 0$. Ruankiaer's frequency distribution also showed the community forest is in seral stages.

3. Stream discharge quantities.

The CF does not provide water services as the villager source in water from state forest. However the forest act as catchment area for watershed.

4. Priority ranking of NTFP.

CFMG collects NTFPs such as Firewood, *Thysanolaena maxima*, *Bambusa nutans*, *Piper nigrum* and fruits of *Terminalia chebula* however the quantity collected on *Piper nigrum* and fruits of *Terminalia chebula* is very minimal. *Bambusa* has consolidated scoring of 2.4 out of 6 and *Thysanolaena maxima* and fuel wood scored 2 and 1.5 respectively. The CFMG should focus on growing *Bambusa nutans* followed by *Thysanolaena maxima*.

Table.1. Vegetation analysis of tress having timber value

Name of the species	R. D (%)	R.F (%)	Abundance	H'	Ds	Raunkiaer's fre. dist.
<i>Schima wallichii</i>	9.50	4.19	4.7	-0.22		
<i>Ailianthus grandis</i>	1.82	1.89	2.0	-0.07		
<i>Symplocus sp.</i>	2.02	2.52	1.7	-0.07		
<i>Szygium cuminii</i>	2.63	2.73	2.0	-0.09		
<i>Talauma hodgsoni</i>	1.92	2.52	1.6	-0.07		
<i>Phoebe lanceolata</i>	1.62	1.68	2.0	-0.06		
<i>Talauma sp.</i>	1.31	1.67	1.6	-0.05		
<i>Meliosoma sp.</i>	1.42	1.34	1.8	-0.06		
<i>Aphanamixis polystachya</i>	1.42	1.26	2.3	-0.59	35.14	16<33>7≠0>0
<i>Tetrameles nudiflora</i>	1.72	1.89	1.9	-0.06		
<i>Pterospermum acerifolium</i>	1.62	1.89	1.8	-0.57		
<i>Dubanga grandiflora</i>	1.62	1.68	1.9	-0.08		
<i>Castanopsis hystrix</i>	2.12	2.31	1.7	-0.05		
<i>Ostodes paniculatus</i>	1.21	1.47	1.5	-0.01		
<i>Michelia champaca</i>	0.30	0.42	1.34	-0.12		
<i>Tonii ciliata</i>	1.12	0.98	1.32	-0.06		

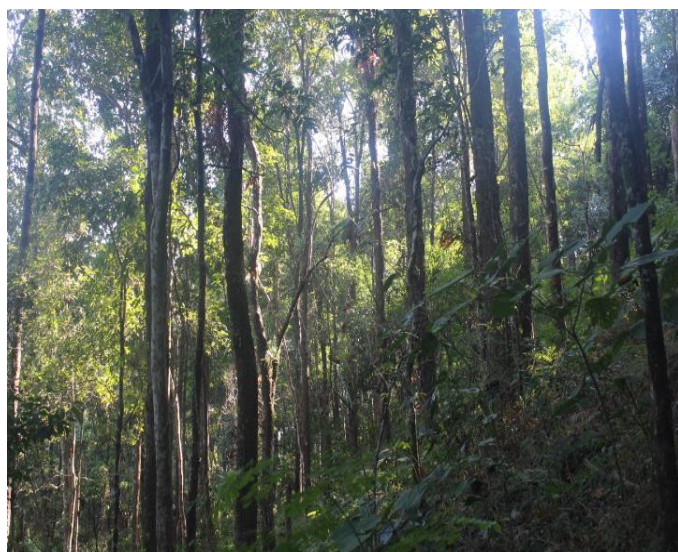
Table.2. Priority ranking of NTFP

NTFP	Fuel wood			<i>Thysanolaena maxima</i>			<i>Bambusa nutans</i>		
	1	2	3	1	2	3	1	2	3
Legend									
Count	37	31	7	22	36	17	18	7	50
%	49	41	9	29	48	22	24	9	66
Score	1.48	0.82	0.09	0.88	0.96	0.22	0.72	0.18	0.66
Total score		2.4			2			1.5	
Grand total score : 6 (2.4+2+1.5)									

Table.3. Economic valuation of Non-Consumptive Use Value

Economic valuation of non-consumptive use values							
Total households	Total ACU	Total Land holding size	Total Annual Income (Nu.)	Education status	Env. Awareness	Grand Total WTP (Nu.)	Extrapolated WTP (Nu.)
20	56	153.6 acres	1,580,000	NFE & Illiterate	High	943,500	1.65 million

ACU: Adult Cattle Unit, WTP: Willingness to Pay.



1. Services availed from Tareythang B Community Forest (CF)

The villagers availed the services very less due to availability of forest products in state forest (most of the forests products are collected free of costs). The CFMG has collected only *Bambusa nutans* for commercial purposes although there are other NTFPs such as *Thysanolaena maxima*, *Piper nigrum* and *Terminalia bellerica*. The total income generated from collecting *Bambusa nutans* was Ngultrum 750 (USD 11.5) from the date of CF establishment. The economic value of CF is estimated around Nu. 1. 22 million (USD 18,846) annually.

2. Community forest assessment for ecosystem services.

Unlike other CF, Tareythang B CF is not dominated by *Schima wallichii* species. The physiognomy of the forest shows uniform distribution and equal occupancy of all species in the community. The forest community has 42 tree and 24 shrub species growing in it with maximum tree species having timber value. The tree species having higher relative density are *Shorea robusta* (7.76%), *Beilschmiedia sp.* (3.88%) *Michelia champaca* (3.67%). The community forest has timber production potential, however most of trees have not reached to harvestable girth size. The tree species showing weaker competition in the community are *Mallotus philippensis*, *Hovenia acerba*, *Cinnamomum glanduliferum* and *Populus gamblei*. The CF has Shannon-Weiner diversity index of 3.39 and Simpson diversity index of 25.81 showing higher diversity of tree species. Ruankiaer's frequency distribution showed almost normal distribution of species without much disturbances in ecology as shown by distribution equation; $39 > 9 > 3 \neq 0 > 0$. Ruankiaer's frequency distribution also showed the community forest is in seral stages.

3. Stream discharge quantities.

The volume of water was estimated using volumetric method. The estimated water flow per minute is 5.18 ft.³/min.

4. Priority ranking of NTFP.

Villager collected NTFPs such as Firewood, *Thysanolaena maxima* and *Bambusa nutans*. However only *Bambusa nutans* was collected from CF for commercial purposes. *Bambusa nutans* has consolidated scoring of 2.36 out of 6 and *Thysanolaena maxima* and fuel wood scored 1.9 and 1.8 respectively. The CFMG should focus on growing *Bambusa nutans* followed by *Thysanolaena maxima*.

Table.1. Vegetation analysis of tress having timber value

Name of the species	R. D (%)	R.F (%)	Abundance	H'	Ds	Raunkiaer's fre. dist.
<i>Shorea robusta</i>	7.76	3.72	4.75	-0.19		
<i>Mallotus philippensis</i>	0.20	0.47	1.00	-0.01		
<i>Phoebe lanceolata</i>	0.62	0.93	1.50	-0.03		
<i>Michelia champaca</i>	3.67	4.19	2.00	-0.03		
<i>Schima wallichii</i>	0.82	1.40	1.33	-0.02		
<i>Szygium cuminii</i>	0.61	0.93	1.50	-0.12		
<i>Beilschmiedia sp.</i>	3.88	3.26	2.71	-0.08	25.81	30>93>3≠0>0
<i>Gmelia arborea</i>	2.24	1.40	3.66	-0.06		
<i>Tonii ciliata</i>	1.63	2.33	1.60	-0.07		
<i>Aglaia sp.</i>	1.84	2.33	1.80	-0.04		
<i>Dalbergia sissou</i>	1.22	1.86	1.5	-0.05		

Table.2. Timber Volume (Measured only timber with sizable girth i.e. circumference >3ft.)

Si. No.	Species	Total Basal Area (Ft. ²) in sampled area.
1	<i>Shorea robusta</i>	24.21
2	<i>Schima wallichii</i>	15.23
3	<i>Beilschmiedia sp.</i>	12.03
4	<i>Mallotus philippensis</i>	7.23
5	<i>Polyathia simiarum</i>	6.7
6	<i>Phoebe lanceolata</i>	3.2

Table.3. Priority ranking of NTFP

NTFP	Fuel wood			<i>Thysanolaena maxima</i>			<i>Bambusa nutans</i>		
Legend	1	2	3	1	2	3	1	2	3
Count	12	38	25	23	31	21	38	32	5
%	16	50.6	33.3	30.6	41.3	28	50.6	42.6	6.6
Score	0.48	1	0.33	0.9	0.8	0.28	1.5	0.8	0.06
Total score		1.8			1.98			2.36	
Grand total score : 6 (1.8+1.98+2.36)									

Table.4. Quantity for stream discharge for drinking water

Radius	Height	Total volume ($\pi r^2 h$)	Time	New height	Volume of water added	Per minute discharge
1.5 ft.	2.5 ft.	17.67 ft. ³	30 min.	4.7 ft.	15.5 ft. ³	5.18 ft. ³ /min.

Table.5. Economic valuation of Non-Consumptive Use Value

Economic valuation of non-consumptive use values							
Total households	Total ACU	Total Land holding size	Total Annual Income (Nu.)	Education status	Env. Awareness	Grand Total WTP (Nu.)	Extrapolated WTP (Nu.)
20	48	152 acres	1350,000	NFE and illiterate	High	875,000	1.22 millions
ACU: Adult Cattle Unit, WTP: Willingness to Pay.							

1. Services availed from Tirkhola Community Forest (CF)

The villagers collected NTFP such as *Rubia manjith*, *Cinnamomum glanduliferum*, *Zanthoxylum armatum*, Firewood and fodder. The CF serve as important source of water to irrigate the *Elettaria cardamomum* field, which is the main cash crop of the village. The CFMG has not collected forest products for commercial purposes and have not generated income although the presence of NTFP in the CF. The economic value of CF is estimated around Nu. 1.55 million (USD 23,961) annually.

2. Community forest assessment for ecosystem services.

Tirkhola CF is located at highest altitude of all the CF under the project study and only CF growing *Alnus nepalensis* tree species. The forest community is different, showing different species diversity and community dynamics. CF The physiognomy of the forest shows uniform distribution and equal occupancy of all species in the community. The forest community has 46 tree species growing in it with maximum tree species having timber value. The tree species having higher relative density are *Castanopsis hystrix* (10.2%), *Ostodes paniculatus* (5.1%) and *Mangifera indica* (7.3%). The tree species showing weaker competition in the community are *Bauhinia variegata*, *Morus macroura*, *Zanthoxylum armatum* and *Aphanamixis polystachya*. The CF has Shannon-Weiner diversity index of 3.4 and Simpson diversity index of 36.3 showing higher diversity of tree species. Ruankiaer's frequency distribution showed no dominance by single species as shown by distribution equation; $40 > 6 > 3 \neq 0 > 0$.

3. Stream discharge quantities.

The estimated flow rate of stream is 9.2 ft³/sec. The water draining out from CF is used for irrigating the *Elettaria cardamomum* field.

4. Priority ranking of NTFP.

The ranking was obtained on *Rubia manjit*, *Cinnamomum glanduliferum* and Firewood. Fuel wood has consolidated scoring of 2.3 out of 6 and *Rubia manjith* and *Cinnamomum glanduliferum* scored 2.1 and 1.5 respectively. Fuel wood is used for heating and cooking purposes and other NTFP were not collected due lack of market. NTFPs were not given much attention as farmer solely dedicate in cultivation of *Elettaria cardamomum* for income generation.

Table.1. Vegetation analysis of tress (timber value) with and NTFP

Name of the species	R. D (%)	R.F (%)	Abundance	H'	Ds	Raunkiaer's fre. dist.
NTFP						
<i>Bauhinia variegata</i>	0.3	0.59	1.2	-0.01		
<i>Cinnamomum glanduferum</i>	3.7	4.71	1.02	-0.1		
<i>Ficus roxburghii</i>	0.3	0.59	1.6	-0.12		
<i>Zanthoxylum armatum</i>	0.3	0.59	1.01	-0.01		
Timber						
<i>Turpinia nepalensis</i>	5.1	5.88	1.8	-0.2		
<i>Alnus nepalensis</i>	4.0	5.29	1.5	-0.2		
<i>Castanopsis hystrix</i>	10.2	7.65	2.7	-0.2		
<i>Mangifera indica</i>	7.3	7.06	2.1	-0.2	36.3	40>6>3≠0>0.
<i>Schima wallichii</i>	4.0	5.29	1.5	-0.1		
<i>Cinnamomum sp</i>	0.8	1.18	1.5	-0.01		
<i>Photinia integrifolia</i>	0.3	0.59	1.01	-0.02		
<i>Michelia champaca</i>	1.4	1.18	2.5	-0.2		
<i>Ehretia acuminata</i>	0.6	1.18	1.2	-0.1		
<i>Symplocus sp.</i>	4.2	5.88	1.5	-0.01		
<i>Beilschmiedia sp.</i>	0.8	1.76	1.02	-0.01		
<i>Tonii ciliata</i>	0.8	1.76	1.6	-0.1		
<i>Szygium cuminii</i>	1.4	1.18	1.01	-0.1		

Table.2. Timber Volume (Measured only timber with sizable girth i.e. circumference >3ft.)

Si. No.	Species	Total Basal Area (Ft. ²) in sampled area.
1	<i>Polyathia simiarum</i>	8.54
2	<i>Castanopsis hystrix</i>	43.69
3	<i>Schima wallichii</i>	19.50
4	<i>Alnus nepalensis</i>	27.65
5	<i>Turpinia nepalensis</i>	20.17

6	<i>Cinnamomum sp.</i>	9.29
7	<i>Symplocus sp.</i>	9.10
8	<i>Mangifera indica</i>	12.52
9	<i>Beilschmiedia sp.</i>	5.92
10	<i>Toni ciliata</i>	6.90
11	<i>Hovenia acerba</i>	2.63

Table.3. Quantity for stream discharge for drinking water

Quantity of stream discharge for irrigation						
Length of stream	Width (mean)	Depth (mean)	Area	Time taken (mean)	Velocity (mean)	Water Discharge
164 ft.	3.3ft	1.05 ft.	3.46 ft. ²	52 sec.	2.6 ft./sec.	9.2 ft ³ /sec.

Table.3. Priority ranking of NTFP

NTFP	Fuel wood			<i>Rubia manjit</i>			<i>Cinnamomum glanduferum</i>		
	1	2	3	1	2	3	1	2	3
Legend									
Count	38	24	13	33	20	22	8	27	40
%	50.6	32	17.3	44	26.6	29.3	10.6	36	53.3
Score	1.5	0.64	0.17	1.32	0.53	0.29	0.36	0.72	0.5
Total score		2.3			2.1			1.5	
Grand total score : 6 (2.3+2.1+1.5)									

Table.5. Economic valuation of Non-Consumptive Use Value

Economic valuation of non-consumptive use values							
Total households	Total ACU	Total Land holding size	Total Annual Income (Nu.)	Education status	Env. Awareness	Grand Total WTP (Nu.)	Extrapolated WTP
12	22	51.8 acres	2,640,000	NFE and illiterate	High	890,000	1.55 millions

ACU: Adult Cattle Unit, WTP: Willingness to Pay.





Ecosystem services valuation of Community Forests of Sarpang Dzongkhag: An assessment for conservation and livelihood.