



Progress Report I



Summary

Project update reports on three community forests (CFs) viz. Dangling, Samdrupcholing and Tashithang CFs under Umling block. Dangling CF was developed to reference site as the reconnaissance survey and forest documentation has showed less human exploitation of natural capital and harbouring of IUCN red-list categorized animal. CFs are developed according to the provision of *Community Forestry Strategy, 2013* which recognizes the area which are prone to human exploitation and natural calamities (Flood prone area) thus many CFs are ecologically unproductive providing minimal ecosystem services.

Dangling CF: The community forest is located at the altitude of 500-650 msl. with an area of 336 acres of sub-tropical forest types. The CF receives 876 ml of rainfall annually and presence of IUCN red-list categorized animals such as *Elephas maxima*, *Buceros bicornis* and *Neofelis nebulosa* are noted.

Samdrupcholing CF: Samdrupcholing CF is located in Sarpang district in the latitude of 26°50'27.72''N and longitude of 90°33'28.89'' E. The altitude ranges from 300 m – 480 m above mean sea level with total geographical area of 136.6 acres. The CF is managed by two villages' viz. *Chubarthang* and *Thongjayzor*. It consists of moist deciduous sub-tropical forest receiving annual precipitation of 883 mm. The CF has *Tectona grandis*, *Michelia champaca* and *Dalbergia sissoo* plantations for timber purpose and *Thysanolina maxima*, *Piper longum* and *Bambusa nutans* for NTFP purpose. The common plant species found in CF are *Schima wallichii* and *Stereaspermum suaveolens*.

Tashithang CF: The CF is located in proximal to Samdrupcholing CF. The altitude ranges from 300m – 480 m above mean sea level with total geographical area of 156.6 acres. The CF is managed by 22 households. It consists of moist deciduous sub-tropical forest receiving annual precipitation similar to Samdrupcholing CF. The CF has *Tectona grandis*, *Michelia champaca* and *Dalbergia sissoo* plantations for timber purpose and *Thysanolina maxima*, *Piper longum* and *Bambusa nutans* for NTFP purpose. The most dominant tree species is *Schima wallichii* and *Stereaspermum suaveolens* and *Ailanthus grandis*.

1. Services availed from Samdrupcholing CF

50% of the CFMG households have availed the provisioning services from the CF after inception 2008 and most required services was fuel wood (31% households) followed by timber (27% households). The most preferred NTFP for commercialization by the CFMG is Bamboo in which 78% of respondents have chosen bamboo as most preferable for commercialization. For Chubarthang villagers, water provision is most valued provision provided by the CF (100% respondents have chosen water as most important provision from the CF).

2. Community forest assessment for ecosystem services.

The highest numerical strength in a CF is represented by *Schima wallichii* with relative density of 12.3 % and least by species *Castanopsis hystrix* with relative density of 0.7%. The CF has diversity index of 3.18 and species richness of 4.47. *Stereaspermum suaveolens*, *Tectona grandis*, *Terminalia bellerica* have highest relative density when compared to fodder, timber and fruit species respectively. Ruankiaer's frequency distribution shows heterogeneous distribution of species and no single species is distributed in the entire range of CF, however the distribution is aligning towards homogenous distribution as shown by distribution equation; $51 > 45 > 4 = 0 < 0$ (Table 1)

3. Stream discharge quantities

The field work was carried out in the month of February. A stream discharge quantities for irrigation and drinking water were calculated using velocity area method and volumetric analysis. The stream discharge quantity for irrigation and drinking water is $382.6 \text{ ft}^3 \text{ minute}^{-1}$ and $0.15 \text{ ft}^3 \text{ minute}^{-1}$ respectively as shown in Table 2.

4. Priority ranking of NTFP

83% of CFMG were interviewed for the ranking of NTFP using five parameters; marketing demand, household benefit, availability, regeneration potential and time consumed for harvesting. The ranking was obtained based on consolidated scoring of priority legend; very high, high, medium, low, lower and lowest. The most prioritized NTFP is *Bambusa nutans*

Table 1. Analytical characters of species of economic importance. Diversity and richness index of entire species in the CF.

Si. No.	Species name	R. F (%)	R. D (%)	Abundance	Shannon H'	Margalef's D _{mg}	Ruankiaer's frequency distribution
Fodder							
1.	<i>Stereaspermum suaveolens</i>	5	4.6	3.4			
2.	<i>Ficus hispida</i>	2.9	3.6	4.7			
3.	<i>Bauhinia variegata</i>	2.9	3	4			
Fruit and fiber							
1.	<i>Terminalia bellerica</i>	3.6	4	4.2			
2.	<i>Phylanthus emblica</i>	3.6	3.2	3.5			
3.	<i>Stercullia villosa</i>	4.3	4.8	4.1			
					3.18	4.47	51 > 45 > 4 ≧ 0 = 0
Timber							
1.	<i>Toona ciliata</i>	3.5	3.4	3.6			
2.	<i>Michelia champaca</i>	2.2	0.9	2			
3.	<i>Dubanga grandiflora</i>	2.9	1.9	2.5			
4.	<i>Tectona grandis</i>	3.7	7.5	6.5			
5.	<i>Szygium formosa</i>	3.4	1.9	2			
6.	<i>Gmelina arborea</i>	2.9	2.1	2.7			
Fuel wood							
1.	<i>Schima Wallichii</i>	8	12	5.8			

Table 2. Quantity of stream discharge for irrigation and 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.	4.09 ft.	0.605 ft.	2.47 ft. ²	0.9 min.	182.2ft/min.	382.6ft ³ /min.

Quantity of stream discharge for drinking water							
Length	Breadth	Height	Total volume	Time	New height	Volume of water	Per minute discharge
1.75 ft.	2.1 ft.	2 ft.	7.3 ft ³	30 min.	1.07 ft.	4.5 ft ³ /30 min.	0.15 ft ³ /min.

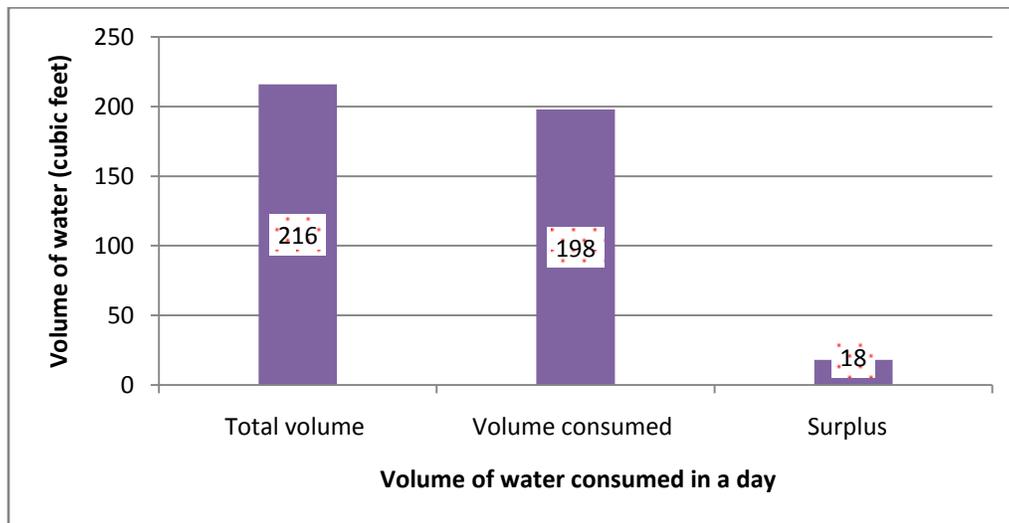


Figure 1. Volume of water consumed and surplus volume in a day.

where 63% percent of respondents have highly prioritized *Bambusa nutans* with total scoring of 10.4 out of 42. No respondents have place bamboo in lower and lowest priority in any parameters. Fruit of *Piper longum* and *Termanilia bellerica* has lowest score of 4.3 and 4.8 each. Fuel wood and *Pseudostachyum polymorphum* has least scored in market demand but high score in household benefit, regeneration potential and availability have placed Fuel wood and *Pseudostachyum polymorphum* third and fourth rank with consolidated scoring of 6.72 and 6.6 respectively, as can be seen in the Figure 4 and Table 4

Table 3. Datasheet for priority ranking of NTFP

Parameter Household	<i>Bambusa nutans</i>					<i>P. polymorphum</i>					<i>T. bellerica</i>					Fuelwood					<i>T. maxima</i>								
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E				
1	1	3	1	1	1	5	2	4	3	5	3	5	5	5	3	4	6	6	4	4	6	1	2	6	2	2	6	2	6
2	1	3	1	1	2	4	4	3	5	5	5	5	6	5	4	3	6	6	4	4	6	2	2	6	1	2	1	4	5
3	1	4	2	1	1	5	1	3	3	3	3	5	6	6	5	4	6	5	5	6	6	2	1	2	2	2	3	4	4
4	1	2	4	1	1	5	3	3	3	3	3	6	5	5	6	5	5	5	4	5	6	4	2	2	2	2	4	1	4
5	1	3	2	1	2	3	2	3	5	3	2	6	6	3	6	4	5	6	6	5	6	1	1	6	1	4	2	4	1
6	1	4	1	1	2	5	3	3	5	6	3	6	6	3	6	4	5	5	4	5	6	1	2	6	1	2	2	4	4
7	1	3	1	1	1	5	4	3	3	5	3	6	6	5	3	4	5	5	4	4	6	1	2	6	1	2	1	2	2
8	1	2	1	1	1	5	4	3	3	5	3	6	6	4	6	4	5	5	4	6	6	1	2	6	6	2	3	2	2
9	1	3	1	1	1	5	2	4	3	3	3	6	6	4	6	4	5	5	5	5	6	1	3	6	2	2	3	2	3
10	1	3	1	1	1	5	2	3	3	3	3	6	5	6	5	4	5	5	4	5	6	1	4	6	2	2	3	2	2
11	2	4	1	1	5	6	2	3	3	3	3	6	5	5	2	4	5	6	5	2	6	1	4	6	4	2	4	2	6
12	1	4	1	2	5	6	1	3	3	2	3	6	5	5	3	4	5	6	4	1	6	2	4	6	4	2	3	2	6
13	1	2	1	2	5	6	3	4	3	3	3	5	5	5	1	4	6	6	4	2	6	4	3	6	4	2	1	2	6
14	1	4	1	1	5	6	3	4	3	3	3	5	5	5	1	4	6	6	4	2	6	2	3	6	4	2	1	2	6
15	1	3	1	1	5	6	4	4	3	3	3	5	5	5	1	4	6	6	4	2	6	2	3	4	4	2	1	2	6
16	1	1	3	1	1	6	3	4	4	3	3	5	5	5	6	4	6	6	6	5	6	4	2	3	2	2	2	1	4
17	2	1	1	3	1	6	3	3	4	4	3	5	6	5	5	4	6	5	6	6	6	4	2	2	3	1	2	4	2
18	1	1	1	3	1	6	3	3	4	4	3	6	5	5	5	4	5	6	6	6	6	2	4	2	3	2	4	2	2

1=57	1=2	1=3	1=1	1=14	1=12
2=12	2=6	2=2	2=4	2=22	2=49
3=10	3=43	3=21	3=1	3=9	3=6
4=6	4=16	4=3	4=29	4=14	4=15
5=5	5=14	5=35	5=28	5=8	5=1
6=0	6=09	6=26	6=27	6=23	6=7

	<i>Bambusa nutans</i>	<i>P. polymorphum</i>	<i>T. bellerica</i>	<i>P. longum</i>	Fuel wood	<i>T. maxima</i>
	1: 63% : 7.6	1: 2.2% : 0.26	1: 3.3% : 0.39	1: 1.1% : 0.132	1: 15.6% : 1.8	1: 13.3% : 1.5
	2: 13.3% : 1.3	2: 6.7% : 0.67	2: 2.2% : 0.22	2: 4.4% : 0.44	2: 24.4% : 2.4	2: 54.4% : 5.4
	3: 11.1% : 0.9	3: 47.8% : 3.8	3: 23.3% : 1.86	3: 1.1% : 0.08	3: 10% : 0.8	3: 6.7% : 0.53
	4: 6.7% : 0.4	4: 17.8% : 1.06	4: 3.3% : 0.19	4: 32.2% : 1.9	4: 15.6% : 0.9	4: 16.7% : 1
	5: 5.6% : 0.2	5: 15.6% : 0.6	5: 38.9% : 1.56	5: 31.1% : 1.2	5: 8.9% : 0.35	5: 1.1% : 0.04
	6: 0	6: 0.9% : 0.2	6: 28.9% : 0.57	6: 30% : 0.6	6: 25.6% : 0.5	6: 7.8% : 0.15
Scoring	10.4	6.6	4.8	4.3	6.72	8.63

A : Market demand

B : Household benefit

C : Availability

D : Regeneration Potential

**E : Time consumed for
collection**

Legend

Weightage

1: Very high priority	12
2: high priority	10
3: Medium priority	8
4: Low priority	6
5: Lower priority	4
6: Lowest priority	2

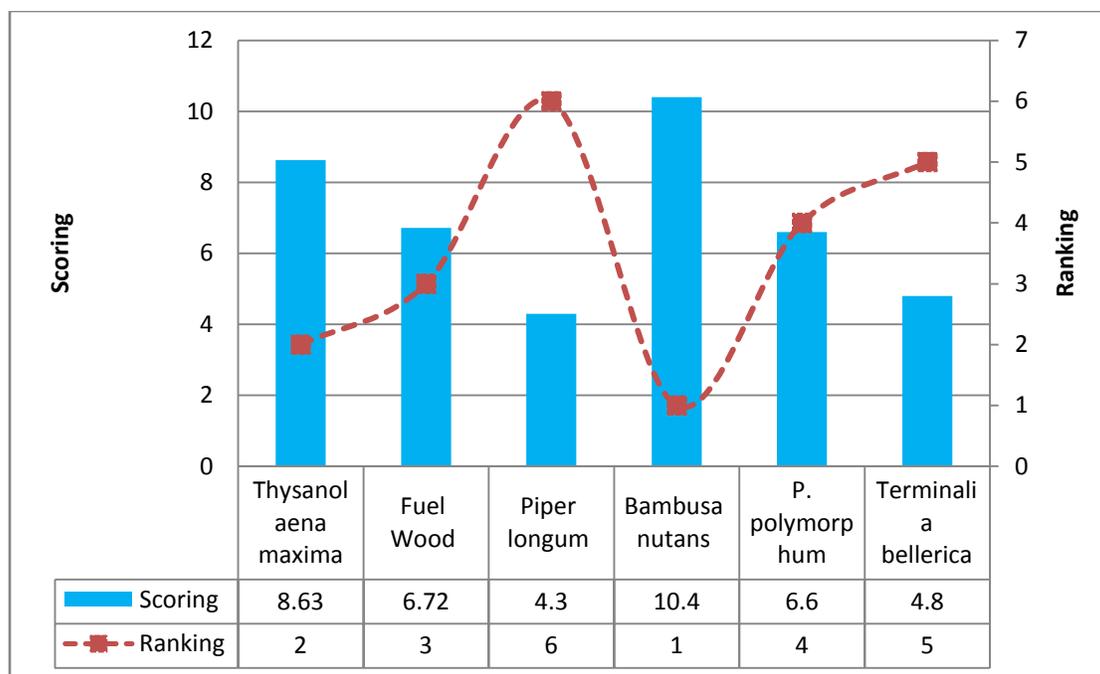


Figure 2. Ranking of NTFP based on scoring

Thysanolaena maxima has uniform scoring in all legend because of it fulfills all the parameters from market demand to household use. The consolidated scoring is 8.63 which signify that the NTFP would be important for economic gain as well as for domestic use. The descending order for the overall NTFP ranking is; *Bambusa nutans*>*Thysanolaena maxima*> Fuel wood >*P. polymorphum*>*T. bellerica* >*P. longum*. Market demand and household use are main requirement for villagers and the NTFPs production is focused on these two parameters. *Bambusa nutans* has highest market demand and fuel wood has highest household use demand. *Bambusa nutans* and *Thysanolaena maxima* have highest scoring in availability and regeneration potential and least is for *Piper longum* and *Terminalia bellerica*.

15. Economic value of NTFP and Water

The total monetary value of provisioning services of Samdrupcholing CF for the year 2015-2016 excluding timber is estimated around Nu.296,587 (US\$ 4,456.3). Monetary valuation of timber was not done due to data deficient on timber volume as well as CF has no production capacity for timber commercialization. The monetary value (gross financial value) of NTFP was Nu.84,020 (US\$1,263) which is 39.5% less than water. The monetary value of water is Nu.212,567 (US\$ 3,195).

Table 4. Monetary value of NTFP

NTFP	Total no. of participating H. H	Total quantity harvested	Unit	Price per unit. Ngultrum (US\$)	Cost of collection Nu. (US\$)	GFV Nu. (US\$)	NFV Nu. (US\$)	CI Nu. (US\$)
	Bamboo	16	1400	Culm	50 (0.75)	17,660	70,000	52,340
<i>Bambusa nutans</i>					(264.87)	(1,052.2)	(786.7)	(1,052.2)
<i>Pseudostachyum polymorphum</i>	2	29	Culm	10 (0.15)	00	290	290	40
						(2.70)	(2.70)	(0.6)
Fruit	10	65	Kg	120 (1.80)	00	7,800	7,800	7,800
<i>Terminalia bellerica</i>						(117.2)	(117.2)	(117.2)
Fruit	7	5	Kg	100 (1.50)	00	500	500	500
<i>Piper longum</i>						(7.5)	(7.5)	(7.5)
Broom	16	80	Bundle	35 (0.52)	1,000 (15)	2,800	1800	2,800
<i>Thysanolaena maxima</i>						(42.1)	(27.1)	(42.1)
Fuel wood	8	73	Loads	35 (0.52)	00	2,555	2,555	638
						(38.4)	(38.4)	(9.6)
Pole	1	5	Pole	15 (0.22)	00	75	75	25
						(1.1)	(1.1)	(0.4)
Total						84,020	65,820	81,803
						(1,261.2)	(987.7)	(1,229.6)

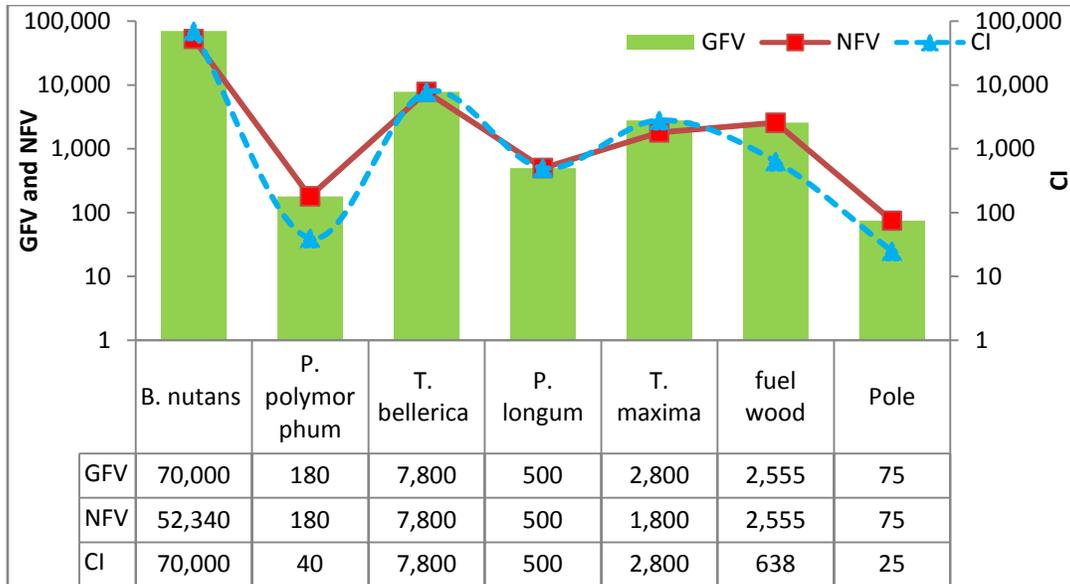
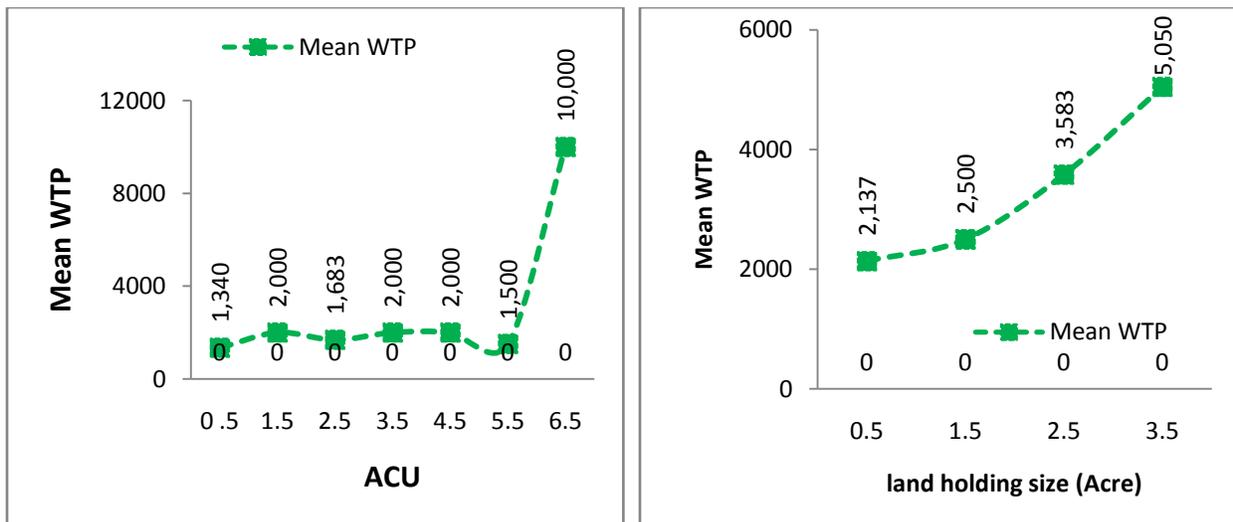
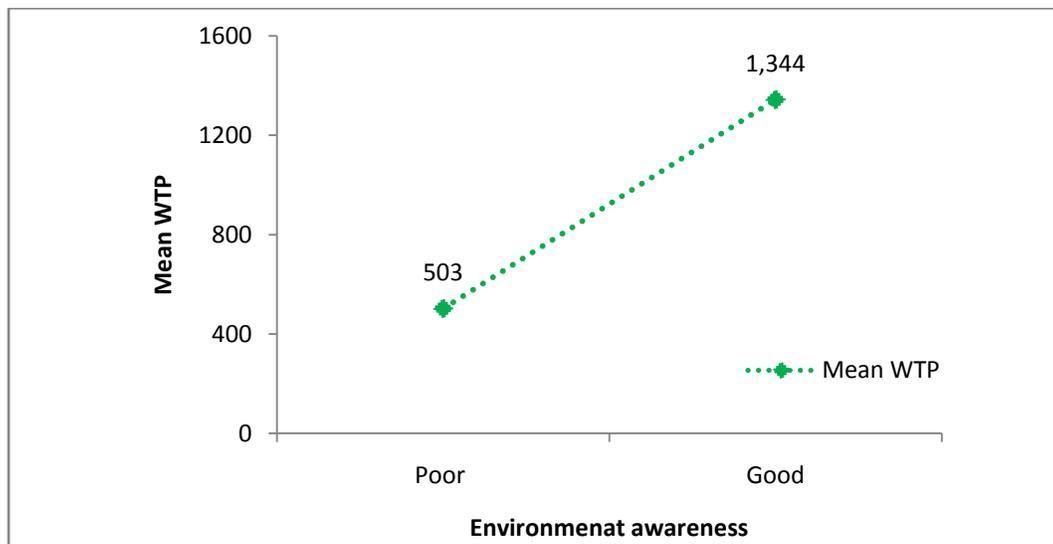
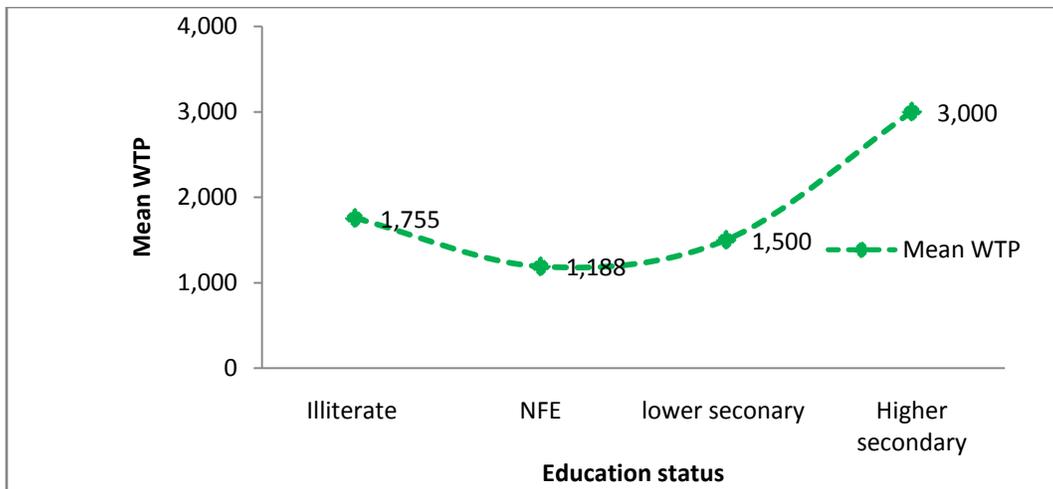
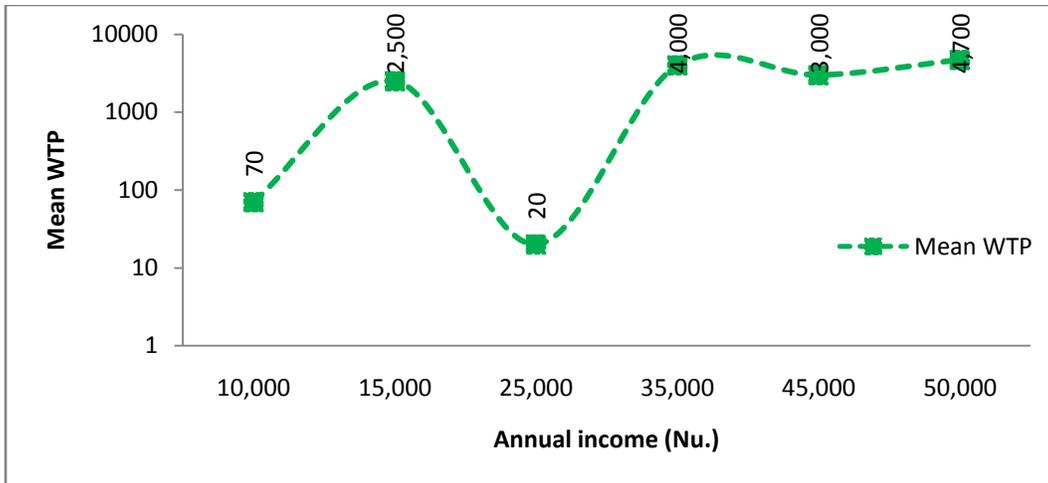


Figure 3. Economic value of NTFP

Economic value of water: The economic valuation of water was done for both drinking and irrigation and it was carried out only in Chubarthang village. The overall mean WTP of 14 households was Nu.11,814 (US\$ 177.6) and maximum WTP was Nu.30,000 (US\$ 451). The extrapolation of overall mean WTP to the total 18 households in Chubarthang village have amounted Nu.212,657 (US\$ 3,195). Amongst all the variables, the landholding size has shown increased mean WTP with increase in landholding sizes. The highest mean WTP of Nu.5,050 (US\$ 75.9) was observed in land holding category and least mean WTP was observed in annual income.





Appendix

APPENDIX 1



Figure 5. Stream gauging to find the volume of water discharge, Measuring the width and depth of stream at each 3.2 ft. respectively.



Figure 6. Volumetric analysis of drinking water. A: Measuring the new height in every minutes and B: Researcher measuring the height after 30 min.

APPENDIX 2



Figure 7. A: Nested quadrat size of 25×25 m and B: Measuring DBH at 1.37 meter high.

APPENDIX 3



A

B



C

D

Figure 8. NTFP collected from the CF. A: *Bambusa nutans*, B: Poles (*Schima wallichii*), C: Farmercarrying fodder collected from CF (*Stereaspermum suaveolens*) and D: Fire wood.

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

APPENDIX 4

Table 5. Analytical characters of CF showing, % frequency, Relative density, Abundance, Shannon wiener diversity and Margalef's index for species richness

Analytical characters of the CF							
Si. No.	Name of the species	% frequency	R. frequency	Relative density	Abundance	H' diversity	Richness Dmg
1	<i>Schima wallichii.</i>	55	8	12.3	5.8		
2	<i>Stereaspermum suaveolens</i>	35	5	4.62	3.4		
3	<i>Ailanthus grandis</i>	30	4.3	3.66	3.1		
4	<i>Terminalia bellerica</i>	25	3.6	4.04	4.2		
5	<i>Tetrameles nudiflora</i>	25	3.6	4.23	4.4		
6	<i>Ilex dipyrena</i>	20	2.9	2.50	3.2		
7	<i>Albizia odoratissima</i>	30	4.3	5.58	4.8		
8	<i>Albizia procera</i>	25	3.6	3.87	4	3.18	4.47
9	<i>Phyllanthus emblica</i>	25	3.6	3.27	3.5		
10	<i>Sterculia villosa</i>	30	4.3	4.81	4.1		
11	<i>Aquilaria malaccensis</i>	20	2.9	2.69	3.5		
12	<i>Acacia catechu</i>	30	4.3	5.39	4.6		
13	<i>Ficus hispida</i>	20	2.9	3.66	4.7		
14	<i>Bombax ceiba</i>	15	2.2	3.42	6		
15	<i>Castanopsis hystrix</i>	20	2.9	0.77	1		

16	<i>Toona ciliata</i>	25	3.6	3.46	3.6
17	<i>Bauhinia purpurea</i>	20	2.9	3.08	4
18	<i>Pandanus furcatus</i>	20	2.9	0.96	1.2
19	<i>Michelia champaca</i>	15	2.2	1.15	2
20	<i>Oroxylon indica</i>	15	2.2	0.96	1.6
21	<i>Syzygium oblatum</i>	20	2.9	2.50	3.2
22	<i>Erythrina arboresecne</i>	25	3.6	3.66	3.8
23	<i>Dubanga grandiflora</i>	20	2.9	1.92	2.5
24	<i>Tectona grandis</i>	30	3.6	7.51	6.5
25	<i>Melia azadarach</i>	20	2.9	1.54	2
26	<i>Syzygium formosa</i>	25	3.6	1.92	2
27	<i>Gmelina arborea</i>	20	2.9	2.11	2.7
28	<i>Alstonia scholaris</i>	15	2.2	2.69	4.6
29	<i>Ammora wallichii</i>	10	1.44	1.54	4
Total		6.85	98.24	100	104

APPENDIX 5

Table 6. Datasheet for the calculation of economic value of NWFP

Total Quantity Harvested (TQH)				
NWFP	Quantity	Units	$\frac{\sum_i^m H C_i}{n}$	$\frac{\sum_i^m H C_i}{n} * PHH (m/n * N)$
<i>Bambusa nutans</i>	1400	culms		1,400
<i>Pseudostachyum polymorphum</i>	130	culms	130/18	29
<i>Terminalia bellerica</i>	65	Kg		65
<i>Piper Longum</i>	5	Kg		5
<i>Thysanolaenamaxima</i>	80	Bundles		80
<i>Pole</i>	70	individual	70/18	5
Fuelwood	45	Power tiller trip	135/18	73.

NWFP	GFV (TQH × P)	CST	NFV	CI
<i>Bambusa nutans</i>	1400 × 50 = 70,000	17,660	70,000-17,660	70000
<i>Pseudostachyum polymorphum</i>	29 × 10 = 180			40
<i>Terminalia bellerica</i>	65 × 120 = 7800			7,800
<i>Piper Longum</i>	5 × 100 = 500			500
<i>Thysanolaenamaxima</i>	80 × 35 = 28,00	1000	28,00-1000	2,800
<i>Pole</i>	73 × 35 = 2555			638
Fuelwood	5 × 15 = 75			25

GFV (Gross Financial value): Total Quantity harvested × Price per unit

CST (Cost of collection): Cost incurred in total hours of collection + Depreciation cost of material used for collection.

NFV (Net Financial Value): Gross financial value – total cost of collection

CI (Cash Income): Quantity sold × Price per unit

$\frac{\sum_i^m H C_i}{n}$; Total amount of individual NWFP collected by CFMG or by household divided by sampled household gives × PHH gives TQH.

PHH: Percentage of participating households.

APPENDIX 6

Table 7. Data sheet of CVM.

Household	land size	WTP	ACU	WTP	level of education	WTP	Env. awareness	WTP	Annual Income	WTP	Total payment capacity
1	2.1 - 3	4,000	4.2	2000	6 to 10	1,500	Good	600	>50, 000	1,900	10,000
2	0.3	3000	0.95	3000	NFE	1000	Poor	500	10,001 - 20,000	2500	10,000
3	3.1-4	5000	2.32	3000	NFE	1500	Good	1000	>50,000	4500	15,000
4	3.1-5	150	2.7	50	Illiterate	20	Poor	10	<10,000	70	300
5	0.8	2000	0.02	1000	11 to 12	3000	Good	1000	>50,000	3000	10,000
6	0.7	50	0.96	20	NFE	5	Poor	5	21,000-30,000	20	100
7	3.1-4	10000	3.66	2000	Illiterate	3000	Good	1000	>50,000	14000	30,000
8	2.1-3	3500	5.4	1500	NFE	1000	Poor	1000	41,000-50,000	3000	10,000
9	2.1-3	2000	1.35	500	NFE	500	Good	500	31,000-40,000	1,500	5,000
10	0.6	3,500	1.24	3500	NFE	2000	Good	2000	>50,000	4,000	15,000
11	1.0-2	2500	3.6	3000	Illiterate	1000	Good	1000	>50,000	2,500	10,000
12	2.1-3	3000	3.6	1000	NFE	2000	Good	2000	>50,000	3,000	10,000
13	2.1-3	3000	2.29	2000	NFE	1500	Poor	1000	31,000-4000	2,500	10,000
14	2.1-3	6,000	7.35	10,000	Illiterate	3000	Good	3000	31,000-40,000	8,000	30,000
Total											165,400

Extrapolation

$$\left(\frac{\sum_i^m H C_i}{n} \right) \times \left(\frac{M}{n} \times N \right)$$

$$\frac{\sum_i^m H C_i}{n} ; \text{Total payment capacity divided by sample size.}$$

$$(165,400/14) \times ([14/14] \times 18) = \text{Nu. 212,657}$$

m: no. of households who is willing to pay

n: total no. of sampled households

N: total no. of households in a village

APPENDIX 7

Table 8. Data sheet for stream gauging and volumetric analysis of drinking water

Quantity of stream discharge for irrigation															
First interval (ft.)				Second interval (ft.)				Third interval (ft.)				Fourth interval (ft.)			
Wid th	Me an	Dep th	Me an	Wid th	Mea n	Dep th	Me an	Wid th	Me an	Dep th	Me an	Wid th	Me an	Dep th	Me an
4.6		0.74		4.9		0.5		3.28		0.5		4.6		0.5	
4.2		0.5		4.5		0.5		3		0.7		4.2		0.58	
4.2	4	0.58	0.6	4.9	4.5	0.5	0.5	4.26	3.7	0.6	0.6	4	4.1	0.66	0.6
3		0.74	2	4.9		0.58	6	5		0.6	2	3.28	3	0.74	1
4		0.58		3.2		0.74		3.28		0.6		4.6		0.58	

$$\text{Area} = 4.09 \times 0.6 = 2.47 \text{ ft}^2$$

Distance: 50m (164 ft.)

Velocity of surface: $164/0.6$

Average time taken: 56 seconds
(0.9 minutes)

$$= 182.2 \text{ ft. per min.}$$

Velocity mean: $K V \text{ surface}$ (K is roughness coefficient)

Actual mean width: 4.09 ft.

$$= 0.85 \times 182.2 = 155 \text{ ft. per min.}$$

Actual mean depth: 0.6 ft.

Total discharge: $K V \text{ surface} \times \text{Area}$

$$= 155 \times 2.47 = 382.9 \text{ ft}^3/\text{second}$$

Table 9. Datasheet for volumetric analysis of drinking water

Quantity of stream discharge for drinking water							
Height (ft.)	Length (ft.)	Breadth (ft.)	Total volume (ft ³)	End time (min.)	New height (ft.)	New Vol. of water	Per minute discharge
1.75	2.1	2	7.3	30	1.07	4.5ft ³	0.15ft ³ / min

Volume of tank: $L \times B \times H$ = $1.75 \times 2 \times$ 2.1 = 7.3ft^3	New volume of tank after 30 min. $L \times B \times \text{New height}$ = $1.75 \times 2 \times 1.07$ = $4.5\text{ft}^3 / 30 \text{ min}$	Discharge of water per minute New vol. / 30 min. = $4.5 \text{ ft}^3 / 30 \text{ min.}$ = $0.15 \text{ ft}^3 / \text{min}$
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