Report of Evaluation of Different Sawmill Technologies Using Multi-Criteria Analysis (MCA)

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Acknowledgement

The sawmill industry is one of the major forest-based primary processing enterprise in Bhutan and various brands of sawmill technologies are being currently promoted in the country. The study on the recovery of different sawmill technologies was carried out in the past by Forest Resources Management Division (FRMD) to facilitate the up-gradation of sawmills in Bhutan but the findings were not implemented due to resistance from the members of the Association of Wood Based Industries (AWBI). Therefore, this study was conducted on the request of the members of AWBI to carry out comparative study on efficiency of different sawmilling technologies in the country.

FRMD would like to thank representatives from Natural Resources Development Corporation Limited (NRDCL), AWBI and Paro Forest Division who were part of the study team and for having actively participated in the conduct of the field work. Without their support, the field work would not have been completed as anticipated.

We would like to thank the sawmill brand promoters in assisting the study team/ committee by identifying the best established sawmill of the brand of sawmill being promoted by them. We also thank Sawmill Owners of Haa for identifying the best established and operating Indian brand of sawmill for this study. This helped us in avoiding introduction of any bias through selection of sawmills, which otherwise would not have been possible.

We greatly appreciate to sawmill owners for allowing us to conduct our field work in their respective sawmills as selected jointly by sawmill promoters, saw millers and agreed by study team. Without their support, the field work for this study would not have been possible.

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Finally, we would like to thank Technical Advisory Committee. (TAC) meeting members for reviewing, commenting and endorsing the report.

Forest Resources Management Division

Table of Contents

List of Tables

Evaluation of Efficiency of Sawmill Technologies Using Multi-Criteria Analysis (MCA): A Case in Bhutan

1. Introduction

Sawmill is a major primary processing plant for converting logs into sawn timber in Bhutan and, different brands of sawmill technologies are currently being promoted in the country. The number of sawmills in Bhutan has increased from 23 in 1979 to 49 in 1990 and there are 138 sawmills and/or integrated sawmills (135 registered with Association of Wood-Based Industries as of 2017 (ABWI, 2017) and 3 not registered) in 2017. Table 1 shows the number of sawmills by Dzongkhag in Bhutan. The Department of Forests and Park Services (DoFPS) has been advocating up-gradation of outdated sawmilling technologies since 2008 but there is still some resistance from existing sawmill owners.

The need for the comprehensive evaluation of sawmill technologies has gained greater significance with the formulation of the National Forest Policy 2011 and the Eleventh Five Year Plan of the Department, which emphasizes on the up-gradation of outdated technologies. The issue was also discussed during a trilateral meeting among Forest Resources Management Division (FRMD), Association of Wood Based Industries (AWBI) and Natural Resources Development Corporation Ltd. (NRDCL) on 18th June, 2017. AWBI members requested the Department to conduct a comparative study on efficiency of sawmills in Bhutan and the meeting decided that a joint study; as proposed by AWBI, to be conducted in 2017.

The objective of this study was to evaluate the efficiency of sawmill technologies in view of timber

Table 1: Inventory of sawmill and/or integrated sawmill

Dzongkhag	Sawmill only	Integrated sawmill	Total
Bumthang	19	1	20
Chhukha	2	10	12
Dagana	0	0	0
Gasa	0	0	0
Haa	22	2	24
Lhuntse	1	0	1
Mongar	4	1	5
Paro	22	2	24
Pemagatshel	1	0	1
Punakha	0	0	0
Samdrupjongkhar	3	1	4
Samtse	3	0	3
Sarpang	5	1	6
Thimphu	11	7	18
Trashigang	4	0	4
Trashiyangtse	1	0	1
Trongsa	1	0	1
Tsirang	1	1	2
Wangduephodrang	7	3	10
Zhemgang	2	0	2
			138

recovery capability, waste production, conversion rate, cost of machines and other associated parameters or criteria to establish a basis for establishment and requirement of up-gradation of sawmills in future.

2. Methodology

This study was carried out jointly by FRMD, NRDCL and AWBI between August and September 2017 in five different types of sawmills (refer Annexure I for list of members of study team). The methodology adopted in this study was based on standard literature search, selection of log, girth class, timber species and specification of dimensions of final sawn timber.

2.1. Literature review

The literature search shows various statistics on conversion efficiencies for different species, sawmilling technologies, and country specific studies. The sawn timber recovery rate is 70.6% for Wood Mizer milling technology, 47% for Stihl Chainsaw and 42.3 % for Husqvarna chainsaw (Owusu et al., 2011). The studies have also revealed the different timber recovery rate for some countries; 53.69 % for southern eastern states of Nigeria (Egbewole et al. 2011), 54.4 % in Malaysia (Gyimah and Adu, 2009) and 60-70% for Venezuela (Ofoegbu et al., 2014). A similar study carried out in Bhutan indicated that the percentage of sawn timber recovered from Wood Mizer, Indian Sawmill, Chinese Sawmill and Lucas machine were 83.41 %, 62.24%, 76.18 % and 64.72 % respectively (FRMD, nd).

The literature on sawmill operations show that the efficiency and turnover rate of the machines are affected by i) skill of the operators; ii) size of the logs; iii) dimensions of the sawn timber, iv) saw kerf and saw blade thickness, v) working environment. However, some of these factors are not directly analysed in this study.

2.2. Selection of sawmills

There are claims that certain brand of sawmills are superior over others in terms of timber recovery and conversion efficiency, thereby reducing waste and increasing production capability of sawmill. It is important for the saw miller and sawmill brand promoter to prove to the Department that their claims are true in our context without relying on advertisement made by sawmill manufacturers. Therefore, a meeting was convened among sawmill dealers, study team and saw millers, through which the sawmill dealers were requested to identify best operationalized sawmill of their brand of sawmill in the country to facilitate unbiased assessment of sawmills (refer Annexure III for minutes of meeting). Five different sawmills selected for the assessment study are:

1. Wood Mizer of M/s Gaphel Sawmill, Thimphu
2. Timber King of M/s Drukgyal Mobile Sawmill, Paro
3. Norwood of M/s Namgay Wood Industry, Dawakha, Paro
4. Indian Machine of M/s G.T. Sawmill Haa
5. Lucas Mill of M/s Lucky Sawmill, Haa

Wood-Mizer, Timberking, Norwood and LucasMill were identified and selected by sawmill dealers while Indian Sawmill was identified and unanimously selected by saw millers of Haa for this study. Therefore, it is reasonable to assume that the selected sawmills were of the highest efficiency among other sawmills of same brand or technology. Sawmills identified for this study are located at Haa (Indian sawmill and LucasMill), Paro (Timbering and Norwood) and Thimphu (Wood Mizer).

2.3. Selection of timber species and log dimensions

Varying size of logs proceed to sawmills for sawing since all timber are extracted from natural forest, comprising of young poles to over matured trees in Bhutan. Therefore, the study team in thorough consultation with saw millers and sawmill promoter, jointly agreed to evaluate the efficiency of sawmills with five girth categories of logs as well as specified length (Refer Annexure IV for minutes of meeting). Similarly, as the wood densities are different for different species, which will have corresponding impact on the conservation rate, the species for each girth category was also agreed jointly as stated above.

The Table 2 shows species and log sizes determined for evaluation of efficiency of sawmills. It was understood that in the event of unavailability of the logs in same girth category, the logs in the nearest girth category will be provided for assessment.

Table 2: Timber species and log sizes

Sl. No	Species	Girth	Length
1	Spruce	3'6" to 3'8"	13'
2	Hemlock	5' to 5'6"	15'
3	Spruce	7' to 7'6"	13'
4	Spruce	9'to 9'6"	12'
5	Hemlock	11'6" to 12'	7'

2.4. Specification of dimensions of final sawn timber

The saw millers, sawmill promoters and study team had extensive disclosure on the sizes of the final sawn timber. We agreed to have twenty five different dimensions for final sawn timber to commensurate the requirement of end users (refer Annexure IV for minutes of meeting). Similarly, it was also agreed that a minimum of five pieces each for given dimension of sawn timber to be sawed at each sawmill. Therefore, entire volume of logs allotted to each sawmills had to be sawn in any of the sizes as defined in Table 3 and were required to saw a minimum of five piece each for all dimension as the sawing a particular dimension of timber will have impact on efficiency. For instance,

sawing entire timber into 5" x 4" size will have less cutting, more recovery and high conversion rate.

Table 3: Minimum number required to be sawed from the predetermined sized sawn timber

Sl. No	Width (inch)	Thickness (inch)	Minimum No. of pieces
1	5	4	5
2	4	3	5
3	3	3	5
4	3	2	5
5	3	1.5	5
6	2	1.5	5
7	12	1.5	5
8	10	1.5	5
9	8	1.5	5
10	7	1.5	5
11	6	1.5	5
12	5	1.5	5
13	4	1.5	5

Sl. No	Width (inch)	Thickness (inch)	Minimum No. of pieces
14	12	1	5
15	10	1	5
16	8	1	5
17	7	1	5
18	6	1	5
19	5	1	5
20	4	1	5
21	3	1	5
22	2	1	5
23	2	0.5	5
24	2	2	5
25	1	1	5

2.5. Measurement of log volume

The log volume was measured using modified quarter girth formula[1] *(Equation 1 and 2),* considering the log as in cylindrical shape

$$V_{log} = \frac{g^2}{4\pi} \; x \; l \qquad (1)$$

Where,

V_{log} *is volume of log in cubit foot*
g *is girth in inches at mid-point*
l *is length of log in feet*

Since 'g' is assumed to have measured in inches, converting 'g'into feet and replacing values in eq. 1, we've

$$V_{log} = \frac{g^2}{4\pi \times 144} \; x \; l = \frac{g^2}{1809.56} \boldsymbol{x \; l} \qquad (2)$$

[1] This is called true volume formula in Bhutan and used for all log volume calculations (commercial and subsidized timber)

2.6. Measurement of sawn timber volume

Sawn timber volume was measured using the cuboid volume formula *(Equation 3 and 4)* as below

$$V_{sawn} = lbw \quad (3)$$

Where,

V_{sawn} *is volume of sawn timber*
l *is length in feet*
b *breadth in feet*
w *is width/thickness in feet*

Since width and thickness of sawn timber is measured in inches, converting inch to feet, we have sawn timber volume formula as below;

$$V_{sawn} = \frac{lbw}{12 \times 12} \quad (4)$$

Where,

l *is length in feet,* b *thickness in inches and* w *is width in inches*

2.7. Volume of offcut [2]

For this study, we measured the volume of off-cuts using the stacked volume formula *(Equation 5).* The offcuts were stacked properly on a flat surface and length, height and breadth of the stack were measured. These measurement were used for estimating the stack volume of offcut.

$$V_{st\_offcut} = lbh \quad 5)$$

V_{st_offcut} *is stacked volume of off-cuts*
l *is length of stack*
h *is height of stack*
b *is breadth off stack*

2.8. Measurement of volume of sawdust [3]

The sawdust produced from sawing 5 pieces of logs in each sawmills were collected in

[2] There are other methods of measuring the exact volume of off-cut such as water displacement method. However, these methods are not adopted in this study as our aim was to compare the volume of off-cuts produce in each sawmill.

[3] There are other methods of measuring the exact volume of saw dust such as water displacement method. However, these methods are not adopted in this study as our aim was to compare the volume of sawdust produce in each sawmill.

tarpaulin sheet and measured using a cuboidal shaped tin with 9'' width, 9'' breadth and 13.5'' height *(Equation 6)*. Then volume of the tin is calculated to determine the volume of sawdust produced in each sawmill.

$$V_{sawdust} = hbw/144 \quad (6)$$

Where $V_{sawdust}$ *is volume of tin/sawdust*
h *is height in feet*
b *breadth in inches*
w *is width inches*

2.9. Conversion rate of sawmill

The conversion rate of sawmill is defined as volume of log sawed per unit time *(Equation 7).* The timber sawing time was recorded after loading a piece of log on the log deck and machine begins sawing. The end time was recorded at the completion of the sawing process while meal breaks are excluded from the total time consumed for sawing given volume of logs.

$$Cr = \frac{V_{log}}{t} \quad (7)$$

Where,
Cr *is the conversion rate*
v_{log} *is volume of log (cft)*
t *is total time required to saw given volume of logs (hr)*

2.10. Evaluation of best performing sawmill technology

All sawmill technologies (except Lucas Mill which operate with circular saw) operates on same principle of horizontal sawing or through and through sawing, which approximately produce same percentage of yield. However, there are other factors affecting the efficiency of sawmills such as environmental, economic and social/technical costs which are different among the different sawmill technologies. Therefore, we adopted an approach called multi-criteria analysis (MCA) to evaluate efficiency of different sawmill technologies from environment, economic and social/technical perspectives. The criteria identified for analysis are grouped into three principles of sustainable forest management, namely environment, economic and social/technical criteria. Each of these criteria were ranked in order of the priority, the weights are determined and scores allotted to each criteria in scale of 0-1, 1-2, and 1-5, where the higher score indicate better performance of sawmills.

2.10.1. Identification of criteria

Following criteria were identified through intensive discussion among the forestry officers within FRMD in line with the discussion with saw millers and sawmill dealers (refer Annexure III for minutes of meeting).

a) Environmental Criteria

ii. Conversion (recovery) capability of machine (%)
iii. Volume of off-cut produced (%)
iv. Volume of sawdust produced (%)
v. Power source
vi. No ancillary consumptions
vii. Quality of final sawn timber

b) Economic Criteria

i. Conversion rate (cft/hr)
ii. Cost of machine
iii. Number of operator

c) Social/Technical Criteria

i. Ability to saw any size (girth) of logs
ii. Ability to produce any size of sawn timber
iii. Ability to saw logs without using other equipment
iv. Low hazard to operators/helpers
v. Mechanical handling during loading and sawing

2.10.2. Ranking and weighting of the Criteria

The fourteen criteria were ranked from 1 to 10 in decreasing order of their importance to sustainable forest management and biodiversity conservation through an extensive discussion in FRMD. The rank '1' was considered the most important criterion while '10' being the least important. Some of the criteria are given same rank as others based on the priority of DoFPS through consultation as indicated above. The environmental criteria were given highest priority over economic and social or technical criteria due to its significance to SFM, biodiversity conservation and pressure on forest resources. **The most technical criteria are ranked lower as compared to others as complementary technologies are always available.**

The weight of the criteria were determined using rank sum method as used by Stillwell et al. 1981 and GITTA. nd. The weight of the rank 'criterion is determined by formula *(Equation 8)* below:

$$W_r = n - r + 1 \qquad (8)$$

Where

W_r *is weight for criterion ranked r,*

n *is number of criteria and*

r *is rank*

For the purpose of comparison, each weight is normalized or standardized by dividing the individual weights by sum of all weights (Stillwell et al. 1981; Roszkowska, 2013; Ananda and Herath, 2009; Al-Hadu et al., 2011). Therefore, the value of normalized weight is in the range of (0 to 1) (Table 4). The standardization of weight enabled comparability among the sets of criteria as all weight were in the same scale of 0-1 as will be explained later 2.10.4.

Table 4: Assignment of ranking and weighing to different criteria

SL. No	Rank	Criteria	Weight (n-r+1)	Normalized wt (wt/sum of wts)
1	1	Conversion capability of machine (%)	14	0.11
2	2	Volume of off-cut % of log volume	13	0.10
3	2	Volume of sawdust produced (%)	13	0.10
4	3	Ability to produce any size of sawn timber	12	0.10
5	4	Conversion rate (cft/hr)	11	0.09
6	5	Cost of machine	10	0.08
7	6	Quality of final sawn product	9	0.07
8	7	Power source	8	0.06
9	8	Ancillary Consumptions	7	0.06
10	9	Ability to saw any size (girth) of log	6	0.05
11	9	Ability to saw logs without using other equipment	6	0.05
12	9	No hazard to operators/helpers	6	0.05
13	9	Mechanical handling during loading and sawing	6	0.05
14	10	No. of operators	5	0.04
			126	1.00

2.10.3. Scale for scoring criteria

The individual criterion was scored in the scale of 5-1, 2-1 and 1-0 depending on the suitability of the scores to criteria (Table 5). The scoring scale is maintained as narrow as possible to appreciate the value of difference among different sawmill technologies.

Table 5: Scale for scoring different criteria

Sl. No.	Rank	Criteria	Scoring Scale and Score				
1	1	Conversion capability of machine (%)	>85	80-85	75-80	70-75	<70
		Score	5	4	3	2	1
2	2	Volume of off-cut % of produced	<20	20-30	30-40	40-50	>50
		Score	5	4	3	2	1
3	2	Volume of sawdust produced (%)	<20	20-25	25-30	30-35	>35
		Score	5	4	3	2	1
4	3	Ability to produce any size of sawn timber	Yes	No			
		Score	1	0			
5	4	Conversion rate (cft/hr)	>40	35-40	30-35	25-30	<25
		Score	5	4	3	2	1
6	5	Cost of machine (Nu. Million)	<1	1-1.99	2-2.99	3-3.99	>4
		Score	5	4	3	2	1
7	6	Quality of final sawn product	Even	Wavy			
		Score	2	1			
8	7	Power Source	Ety*	FF*			
		Score	2	1			
9	8	No ancillary Consumptions	Yes	No			
		Score	1	0			
10	9	Ability to saw any size (girth) of log (different)	>10	>9-<10	>7-<9	>5-<7	>3-<5
		Score	5	4	3	2	1
11	9	Ability to saw logs without using other equipment	Yes	No			
		Score	1	0			
12	9	Low hazard to operators/helpers	Yes	No			
		Score	1	0			
13	9	Mechanical handling during loading and sawing	Yes	No			
		Score	1	0			
14	10	No. of operators	>=5	4	3	2	1
		Score	1	2	3	4	5

* Ety is electricity and FF is fossil fuel

2.10.4. Weighted Summation

Since scores are in the different scale, it is important to standardize the scores into commensurate units to measure the performance. The scores are standardized using following formulae *(Equation 9)* (for criteria where more is better) (Ananda and Herath, 2009; Al-Hadu et al., 2011).

$$S_{smj} = \frac{x_{smj} - min_j}{max_j - min_j} \qquad (9)$$

Where:

S_{smj} *is the standardized performance score for the sawmill type (sm) against the jth criterion*

x_{smj} *is the performance score for the sawmill type (sm) against the jth criterion*

min_j *is the minimum performance score for all sawmill types against the jth criterion*

max_j *is the maximum performance score for all sawmill types against the jth criterion*

Overall performance score for each sawmill type is calculated using formulae *(Equation 10)* below

$$V_{sm} = \sum_{j=1}^{m} W_j S_{smj} \qquad 10)$$

Where V_{sm} *= Overall performance of the sawmill type (sm) relative to the other sawmill types,* S_{smj} *the standardized value of* x_{smj} *(the performance measure for the 'sm' sawmill type against the jth criterion),* W_j *= the weight of the jth criterion*

3. Data Collection and Analysis

All sawmill were allotted five pieces of logs of different girth class and total log volume of timber differed slightly due to differences in the dimensions of logs (Table 6). Individual pieces of sawn timber from each log were measured separately in all sawmills. The total time consumed from the start of the sawing until completion of sawing of entire volume of logs was recorded for all sawmill with mobile phone timer. Other observations recorded in this study include number of operators employed, use of chemicals or other substances, hazard to operators, sawing and handling processes and cost of the machine itself.

The data collected were analysed using basic mathematical operations, qualitative interpretation of some information and multi-criteria analysis for evaluation of

performance of different sawmills discussed in section 2.10. ***It should be noted that the performance scores of the Norwood Sawmill is based on only two smaller girth logs as it could saw only 36.57 cft of logs against actual allotment of 229 of timber or only two logs against 5 logs allotted.***

Table 6: Log dimension and volume of logs allotted to different sawmill

Sawmill Type	Spruce (g x l)	Hemlock (g x l)	Spruce (g x l)	Spruce (g x l)	Hemlock (g x l)	Total log vol.
Indian Sawmill	3'7'' x 13'7"	5' 2'' x 15'11''	7'4'' x 13'3''	9'2'' x12'3''	11'11'' x 8'1''	
Volume cft)	13.88	33.81	56.7	81.91	91.35	277.65
Lucas Mill	3'7" x 13'2''	4'10'' x 15'2''	7'7'' x 14'	8'9'' X 12'1''	10'7'' x 6'10''	
Volume cft)	13.45	28.2	64.07	73.62	60.91	240.24
Norwood	3'4'' x 13'5''	4'6" x 15'4''	7'10" x 14'	8'8" x 11'	10'3'' x 7'	
Volume cft)	11.86	24.71	68.36	65.75	58.52	229.2
Timberking	3'10" x 16'2''	5' x 15'9''	7'5" x 11'10''	9'5" x 12'	10' x 7'1''	
Volume cft)	18.9044	31.3336	51.7981	84.6769	56.3673	243.08
Woodmizer	3'7" x 13'4''	4'7" x 15'5''	8'2" x 12'8''	9'6" x 10'	10'7" x 7'3''	
Volume cft)	13.62	25.77	67.23	71.82	64.62	243.06

Note: 'g' is mid girth of the log and l is length of the log

4. Results

4.1. Percentage of sawn timber produced

Except for the Norwood, all other sawmill has successfully completed sawing entire volume of logs allotted to them. The Norwood could not handle three large logs and sawed only two smaller girth of logs for some technical issues (height and width limitation of the machine). The volume of sawn timber is calculated with equation 4. The Timberking produced the highest percentages of sawn timber (87.30 % of log volume) and LucasMill produced the lowest (67.04 % of log volume) (Table 7).

In Indian Sawmill and LucasMill, there is no need of splitting the large logs. However, in Timberking, Wood-Mizer and Norwood, the splitting was required for logs having mid-girth larger than 9', 10' and 7' respectively. Moreover, the Norwood could not saw log with mid-girth more than 7' even after splitting.

Table 7: Percentage of sawn timber produced by different sawmills

Particulars	Indian sawmill	Lucas-Mill	Timber-King	Wood-Mizer	Norwood	Remarks
Volume of log sawed (cft)	277.65	240.2	243.08	243.06	36.57	The percentage of sawn timber produced by Norwood is based on two smaller girth logs only.
Volume of sawn timber produced (cft)	231.47	161.1	212.2	211.09	27.83	
Percent of sawn timber produced	**83.37**	**67.04**	**87.3**	**86.85**	**76.1**	

4.2. Percentage volume of offcuts

The comparison of percentages of offcuts produced by different sawmill technologies is reported in Table 8 and were determined using equation 5. The LucasMill produced the highest percentage of offcuts (29.97%) while Timberking produced the least (18.43%).

Table 8: Percentage of offcuts produced by different sawmills

Particulars	Indian sawmill	Lucas-Mill	Timber-King	Wood-Mizer	Norwood	Remarks
Volume of log sawed (cft)	277.65	240.24	243.08	243.06	36.57	
Volume of off-cut	80	72	44.8	54	4	
Offcut percent	28.81	29.97	18.43	22.22	10.94	

4.3. Percentage volume of sawdust

The percentage of sawdust produced by the LucasMill was the highest among the different sawmills (50.87 %) while that of the Timberking was the lowest (18.14%) (Table 9) and were calculated using equation 6.

Table 9: Percentage volume of sawdust produced by different sawmills

Particulars	Indian sawmill	Lucas-Mill	Timber-King	Wood-Mizer	Norwood
Volume of log sawed (cft)	277.65	240.24	243.08	243.06	36.57
Volume of Saw dust produced (cft)	54.81	122.22	44.1	57.33	8.19
Sawdust percent	**19.74**	**50.87**	**18.14**	**23.59**	**22.40**

4.4. Conversion rate

Among the sawmills examined in this study, LucasMill exhibited the highest conversion rate of 43.52 cft per hour while Indian Sawmill had the least conversion rate of 27.54 cft per hour (Table 10) and were calculated with equation 7.

Table 10: Conversion rate of different sawmills

Particulars	Indian sawmill	Lucas-Mill	Timber-King	Wood-Mizer	Norwood
Volume of log sawed (cft)	277.65	240.2	243.08	243.06	36.57
Total time in hr.	10.08	5.52	7.2	5.95	3.35
Timber Conversion rate (cft/hr)	**27.54**	**43.52**	**33.76**	**40.85**	**10.92**

4.5. Associated environmental, economic and social costs of sawmilling/ sawmill technology

The various environmental, economic and social/technical cost in the context of this study are assessed and reported in Table 11. Except for the LucasMill, all other sawmill technologies can saw timber into any given size. The LucasMill cannot saw planks of more than 10'' width. The complete set of Timberking (model 2000) is the most expensive technology while Indian sawmill is the cheapest of all sawmills. The quality of sawn timber are very good in all sawmill with even surfaces. However, in case of Indian sawmill, a few sawn timber with wavy surface are observed due to manual sizing of the timber in vertical band saw.

The Timberking is being operated by diesel while Norwood is operated by petrol engine. The rest of the sawmill technologies are operated by electricity. Diesel is used as lubricant in Indian sawmill and consumes approximately 1 litre of diesel on daily basis while water is being used as lubricant in other sawmill types.

The Indian Sawmill and LucasMill can handle any girth and length of logs while other sawmill can handle any length of logs but there are technical limitations when it comes to girth of the logs. The Norwood, Timberking and Wood-Mizer used in this study could not handle logs of more than 7', 9' and 10' mid-girth respectively without use of power chain saw. Therefore, these sawmill require additional equipment such as power chain saw for splitting large girth logs.

All sawmills except Indian sawmill is portable in nature but this criterion is not included in the evaluation as the Department is discouraging the use of potable sawmills. The Timberking, Wood-Mizer and Norwood has a mechanical hydraulic system for loading and turning of logs which are not available with Indian Sawmill and LucasMill. However, hydraulic system has specified capacity of loads for lifting and loading.

The operation of Indian Sawmill is potentially dangerous to operators compared to other sawmills on three accounts i) application of diesel as a lubricant on running saw blade frequently in both on log and vertical band saw manually, ii) manual push and pull of heavy planks through vertical band saw, and iii) heavy manual handing poses high risk of accidents. In other sawmill types, heavy manual handling is limited to getting the logs near the sawmill log lifting hydraulic or some timer loading in Timberking, Norwood and WoodMizer. No manual handling of large planks are involved as in case of Indian sawmill.

The number of operator employed varied marginally among various sawmill types with 5 operator and helpers in Indian sawmill to 2 operators or helpers in Norwood. The number of helper in case of loading large logs in any sawmill is sometimes more than 10 people.

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Table 11: Various environmental, economic and social/technical cost associated with sawmill technologies

Parameters	Indian Sawmill	LucasMill	Timberking	WoodMizer	Norwood
Ability to produce any size of sawn timber	Yes	No. Cannot saw > 10" width	Yes	Yes	Yes
Cost of machine (Nu.)	600000	1059000	3900000	3770000	1800000
Quality of final sawn product	Even as well as wavy due to manual handling	Even	Even	Even	Even
Power source	Electricity	Electricity	Fossil Fuel	Electricity	Fossil Fuel
Ancillary Consumptions	Diesel	Water	Water	Water	Water
Ability to saw any size (girth) of log	Yes	Yes	No. Cannot saw >10' mid-girth	No. Cannot saw >9' mid-girth	No. Cannot saw >7' mid-girth
Ability to saw logs without using other equipment	Yes	Yes	No. Power chain saw to split required	No. Power chain saw to split required	No. Power chain saw to split required
Portability	No	Yes	Yes	Yes	Yes
Mechanical handling (loading and sawing)	No	No	Yes. Hydraulic system for lifting and turning logs	Yes. Hydraulic system for lifting and turning logs	Yes. Hydraulic system for lifting and turning logs
Hazard to operators and helpers	High. The log has to be fed manually by operator for sizing in vertical band saw. Push and pull of planks in band saw, application of diesel	Low	Low	Low	Low
No. of Operators	5	3	4	4	2
Saw blade thickness	1.5mm to 2mm	7mm	1.5mm to 2mm	1.5mm to 2mm	1.5mm to 2mm

4.6. Best performing sawmill technology

The Wood Mizer has scored highest weighted sum of 0.78 (78%) while LucasMill and Indian Sawmill scored the least weighted sum of 0.56 (56%) on Multi-Criteria Analysis (MCA). The summary of result is described in Table 12 and the detail analysis reported in Table 13.

Table 12: Summary of performance efficiency of sawmill technologies

Sawmill Type	Performance
Indian Sawmill	56%
LucasMill	56%
Timberking 2000	73.69
Woodmizer LT70	78.44
Norwood HD36	64.62

5. Discussion

The percentage of yield of sawn timber from sound and cull free logs is highest in the Timberking (model 2000) at 87.3% closely followed by Wood-Mizer (model LT70) with 86.85% and Indian Sawmill with 83.37%. The Norwood (HD36) and LucasMill yielded 76.1% and 67.04%. It should be noted that the percentage of yield of Norwood is based on sawing only two smaller girth logs. This indicates that those sawmill technologies operating on the basic principle of horizontal sawing with saw blade thickness of 1.5mm to 2mm yield approximately equal percentage of yield. The yield percent of the LucasMill is lowest as the saw blade is thicker resulting to more waste. In principal, the wastage from the LucasMill is 33% in the form of off-cut and sawdust. Therefore, establishment and operation of such sawmills should be scrutinized and regulated by the Department of Forests and Park Services. The wastage as discussed above is well represented by the stacked volume of off-cut and free volume of sawdust. The percentage of volume of off-cuts produced by the LucasMill is the highest with 30%, closely followed by Indian Sawmill (29%) while Norwood produced the least wastage in the form of off-cut with 11%. Similarly, the LucasMill produced 51% sawdust compare to less than 25% by other sawmills.

The MCA revealed that the overall performance of Indian Sawmill and LucasMill is 56% each while that of Wood-Mizer is 78%, Timberking is 74% and Norwood is 65% when evaluated on 14 closely related criteria. Therefore, the Department need to fix a minimum performance standard for sawmills in the country. Upon fixing the minimum standard, Department may have to strictly regulate the establishment of new sawmills while operation of existing sawmill has to be monitored.

6. Limitation

i. The sampling unit for this study is restricted to one sawmill each of various brands and the impact of skilled operators on the efficiency of the machines could not be assessed

ii. The timber recovery percent reported here does not reflect the actual timber recovery by the various sawmills and it is not suitable for timber pricing purpose. It is the percentage of sawn timber production from sound logs without cull.

iii. The Norwood sawmill could not saw all five logs allotted for assessment.

iv. This results cannot be generalised for other brands of sawmills.

7. Recommendations and conclusion

Through this study we could conclude and recommend following

i. The MCA overall performance of the sawmill technologies vary from 56% to 78%. Therefore, the Department should fix the minimum overall performance of existing as well as up-coming sawmills in the country.

ii. The operation of sawmills with high wastage should be strictly regulated and issuance of forestry clearance for establishment in future may be reviewed..

iii. The yield percent reported here is from the sound and cull free logs. Therefore, yield percent reported here is not suitable for pricing purpose.

8. Endorsement by TAC

The report was presented twice to Department's Technical Advisory Committee (TAC) during 5th Session on 9.10.2017 and 6th Session on 20.12.2017. The 6th TAC endorsed the report and decided to following actions:

i. Only stationary sawmills will be promoted in the country

ii. The minimum performance efficiency of sawmills subject to 14 criteria used in this analysis is 70%. Henceforth, the operation and establishment of sawmills with less than 70% performance efficiency shall be regulated strictly.

iii. The use of LucasMill will be regulated strictly.

Table 13: Detail evaluation of efficiency of different sawmills using MCA

Sl. No.	N_wt	Rank	Particulars	Indian Sawmill			Lucas Mill			Timberking 2000			Wood Mizer LT70			Norwood HD36		
				Score	S_{isj}	Wx S_{isj}	Score	S_{lmj}	Wx S_{lmj}	Score	S_{tkj}	Wx S_{tkj}	Score	S_{wmj}	Wx S_{wmj}	Score	S_{nwj}	Wx S_{nwj}
1	0.11	1	Conversion capability of machine (%)	4	0.75	0.1	1	0.00	0.083	5	1	0.11	5	1	0.1	3	0.5	0.06
2	0.10	2	Volume of off-cut % of log volume	3	0.00	0	3	0.00	0	5	1	0.1	4	0.5	0.1	5	1	0.1
3	0.10	2	Volume of sawdust produced (%)	5	1.00	0.1	1	0.00	0.103	5	1	0.1	4	0.8	0.1	4	0.8	0.08
4	0.10	3	Ability to produce any size of sawn timber	1	1.00	0.1	0	0.00	0.095	1	1	0.1	1	1	0.1	1	1	0.1
5	0.09	4	Conversion rate (cft/hr)	2	0.25	0	5	1.00	0.022	3	0.5	0.04	5	1	0.1	1	0	0
6	0.08	5	Cost of machine (Nu. Million)	5	1.00	0.1	4	0.67	0.079	2	0	0	2	0	0	4	0.7	0.05
7	0.07	6	Quality of final sawn timber	1	0.00	0	2	1.00	0	2	1	0.07	2	1	0.1	2	1	0.07
8	0.06	7	Power source	2	1.00	0.1	2	1.00	0.063	1	0	0	2	1	0.1	1	0	0
9	0.06	8	No ancillary consumption (e.g diesel)	0	0.00	0	1	1.00	0	1	1	0.06	1	1	0.1	1	1	0.06
10	0.05	9	Ability to saw any size (girth) of log	5	1.00	0	5	1.00	0.048	3	0.3	0.02	4	0.7	0	2	0	0
11	0.05	9	Ability to saw logs without using other equipment	1	1.00	0	1	1.00	0.048	0	0	0	0	0	0	0	0	0
12	0.05	9	No/low hazard to operators/helpers	0	0.00	0	1	1.00	0	1	1	0.05	1	1	0	1	1	0.05
13	0.05	9	Mechanical handling during loading and sawing	0	0.00	0	0	0.00	0	1	1	0.05	1	1	0	1	1	0.05
14	0.04	10	No. of operator and helpers	1	0.00	0	3	0.67	0	2	0.3	0.01	2	0.3	0	4	1	0.04
	1					**0.56**			**0.56**			**0.74**			**0.78**			**0.65**

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Annexure I: Sawmill Assessment Team Members

1. Lobzang Dorji, Chief Forestry Officer, FRMD
2. Pema Tshewang, Dy. Chief Forestry Officer, Paro Forest Division
3. Dorji Wangdi, Sr. Forestry Officer, FRMD
4. Dawa Zangpo, Sr. Forestry Officer, FRMD
5. Kuenzang Lham, Forester, FRMD
6. Namgay Bidha, Forester, FRMD
7. Sangay Tshering, FRMD
8. Pema Tenzin, FRMD
9. Gyeltshen, FRMD
10. Kencho Tshering, Association of Wood Based Industries, Thimphu
11. Dasho Gyeltshen, Vice President, AWBI, Paro
12. Pem Tshering, Executive Member, AWBI, Paro
13. Rinchen Khandu, President, AWBI, Haa
14. Tshering Dorji, Executive Member, AWBI, Haa
15. Tshering Wangchuk, Executive Member, AWBI, Thimphu
16. Tashi Penjore, Regional Manager, Rinpung Region, NRDCL
17. Kinley Tenzin, Manager, Production Division, NRDCL, HQ
18. Five Sawmill owners
19. Sawmill promoters/dealers (as observer)

Annexure II: Ranking of the criteria and justification for ranking

Rank	Particulars	Justification
1	Conversion capability of machine (%)	The conversion capability and sawn timber production capacity of sawmill is ranked 1 as most priority criterion. The high percentage of sawn timber production will reduce wastage and increase availability of sawn timber in the market. As a result, we need to cut less trees and enhance SFM and biodiversity conservation.
2	Volume of off-cut produced (%)	This is closely related to criterion ranked 1. The more percentage of off-cut means more loss of timber which otherwise can be converted into suitable and usable timber. Therefore, it is ranked 2.
2	Volume of sawdust produced (%)	This is directly related to the saw blade thickness, which leads to thicker saw kerf and higher volume of sawdust production and lower volume of sawn timber produce. It is similar to criteria 2 and ranked 2.
3	Ability to produce any size of sawn timber	Specific size of the timber is often required in any construction and wood based industries. Similarly, the ability to saw any size of timber will have direct impact on timber recovery because sawing timber in different sizes can reduce waste in the form of off-cuts. Therefore, ranked 3.
4	Conversion rate (cft/hr)	The conversion rate of sawmill is directly related to production capacity of sawmills. The higher conversion rate will facilitate high revenue generation leading to shorter payback period. Therefore, it is ranked 4.
5	Cost of machine (Nu. Million)	Cost of the machines is one of the economic constraints. The brand of sawmill technology promoted should not only be efficient but also should be affordable to common people. Therefore, ranked 5.
6	Quality of final sawn timber	The quality of surface of the sawn timber is very important. The wavy and uneven surface will lead to further loss of timber during processing.
7	Power source	Use of cleaner energy is very important from perspective of climate change. Similarly, we have surplus electricity production while import petroleum product (diesel and petrol).
8	No ancillary consumption (e.g diesel)	Ancillary consumption will not only increase the operation cost but also has an environmental impact from use of chemical such as diesel.

9	Ability to saw any size (girth) of log	Technically any size of logs are bound to come from our natural forest. Therefore, any sawmill technology should be able to saw all logs coming out from the forests. This will not only facilitate reducing the wastages but also enhance social service.
9	Ability to saw logs without using other equipment	Often we will not have access to other essential equipment for splitting the logs. Use of power chain saw will lead to increase in wastage of timber. Therefore, ability of sawmills to saw any timber without using other equipment is very important
9	No/low hazard to operators/ helpers	Health and safety of the operators is extremely important in any industry. Good working environment, safety to workers will help enhance production capacity and conversion rate.
9	Mechanical handling during loading and sawing	Use of mechanical means reduces the manual handling processes. Reduces hazard to operators as well as help in reducing the operational cost and enhance the conversion rate.
10	No. of operator and helpers	It is directly related to operation cost. But the employer has flexibility to employee as many employee as possible depending of volume of timber input.

Annexure III: Minutes of meeting with sawmill dealers/sawmills and sawmill assessment team

Minutes of meeting with sawmill dealers and sawmill recovery assessment

Date: 10/8/2017
Venue: Risum Resort, Haa
Time: 6pm

Discussion
The meeting was chaired by the CFO, FRMD on the ongoing recovery assessment of the timber among the different sawmills. He welcomed all the participants consisting of sawmill dealers and the committee members for the meeting and thanked those participants who have travelled from Thimphu and Paro to discuss the issues pertaining to the timber recovery assessment.

He stated that some issues had come up during the process of assessment as the FRMD has failed to communicate with the sawmill dealers to proof to Department that the particular brand of sawmill is better than other in terms of recovery, efficiency and safety features. This is because there is standing government order of 2008 where all old sawmill has to be replaced. In the event that happens, Department should be able to recommends to government the list of sawmills that should be promoted in Bhutan considering declining trend in timber coming out from the forest.

He further stressed that the present recovery assessment has been carried out as there were complaints from some sawmill promoters that his or her brand of sawmill have been found inferior to other brand of sawmill based on study done in the past. Similarly, the issue was also discussed during a meeting with AWBI on June 18, 2017 at Tashi Namgay Resort, Paro and agreed to redo the assessment to validate the findings of the past studies.
He highlighted that sawmill dealers who import different brands of sawmill to Bhutan are responsible to prove to Department that his/her brand of sawmill is superior over other brand. The assessment should be done with following set of parameters

1. Recovery rate
2. Efficiency
3. Safety features
4. Energy Consumptions
5. Ancillary consumptions
6. Environmental Impacts
7. Number of operators and helpers

He acknowledged that FRMD has failed to communicate with timber recovery assessment team prior to start of the ongoing recovery assessment and there has been some form of miscommunication among the recovery assessment team. Therefore, it is imperative for to discuss several issues here in the meeting.

1. Sawmill brand promoters
Discussion
Since new sawmill brand promoters are responsible to proof to government that his or her sawmill is superior over other brands of sawmill, an opportunity should be given to him or her to proof to us. Therefore, sawmill promoters to agree on what kind of timber should be sawn, in what form, what quantity and where? Each sawmill promoters were given an opportunity to speak on why should their brand of sawmill be promoted. Different sawmill dealers spoke on the their brand of sawmill and requested department/recovery assessment team to provide the set of parameters of assessment. They also acknowledge that all sawmills works on the same principle and therefore recovery should be same.

Decision

i. The recovery assessment team to define the criteria for assessment

ii. All sawmill works on the same principle and therefore, recovery of each sawmill should be logically same.

2. Form of timber to be sawn

Discussion

Some sawmill dealers proposed that to compare recovery and efficiency of the sawmill, all brands of sawmill should saw 12'' x 12'' block into different sizes. Some suggested that all sawmills should saw round logs as sawing blocks will not help in assessing the ability of sawmills to saw the different log sizes. After a prolonged deliberation, the meeting decided the following

Decision

i. The all five brands of sawmill shall saw timber in round form or logs from different girth classes.
ii. Timber recovery assessment team shall determine the girth classes and length of the timber.
iii. Timber recovery assessment team shall also determine sawn timber sizes.

3. Identification of sawmills for assessment

Since the report produced from this study will have wider impact on use of particular brand of sawmills and it is possible that sawmill brand promoters will not agree on the findings of the study, they should proof to committee the recovery, efficiency, safety and environmental impacts of his/her brand of sawmill. Therefore, they should identify the sawmills for sawing logs themselves and sawmill promoters identified the following sawmills

1. The Wood Mizer promoter identified M/s Ghaphel Sawmill, Thimphu
2. The Norwood promoter identified M/s Namgyel Sawmill, Dawakha Paro
3. The Timber King Promoter identified M/s Drukgyal Mobile Sawmill, Paro
4. Indian Sawmill representative identified M/s G T Sawmill, Haa
5. The Lucas Mill promoter conveyed next M/s Reki Sawmill, Haa

4. Outcome of works carried for past 2 and half days

The sawmill representatives and some participants raised the issue that the result works carried out in last 2 and half days should be accounted. The CFO, FRMD clarified that since not all sawmills are provided with same size of logs and our intention to saw 400cft of timber and declare the results at the end of the study was defeated as some kind of results were floated in the social media which will draw criticism from different sectors of life. Therefore, before everything becomes worse, we should focus on way forward to complete the assessment. He also stressed that the re-assessment will give the same result, as the methodology of the assessment will be same. He further stressed that he is not in anyway favoring particular brand of sawmill and result of this study will be useful for department in the event Government seeks recommendation from department to promote some brand of sawmill in the country. After a prolonged discussion, the participants decided following

1. To re-conduct the assessment with set of parameters and logs of different girth classes.
2. Timber recovery assessment team to decide on the parameters and other features

Following the above discussion and decisions, the timber recovery assessment team met separately to discuss on the different parameters of assessment

5. Number of logs to be provided for sawing

The recovery assessment team deliberated thoroughly on what kinds of logs should be provided for assessment and how many logs should be enough to provide comprehensive recovery, efficiency and energy consumption assessment. Some members proposed to saw one log each from each girth category from 3' girth to maximum girth of logs that is extracted from our forest while others felled some average girths should be taken and should suffice the requirement of the current study. Finally, the recovery assessment team unanimously agreed to provide 5 logs each from average girth classes.

6. Girth classes

The recovery assessment committee set the following girth classes for assessment

1. 3' to 3.6''
2. 5' to 5'6''
3. 7' to 7'6''
4. 9' to 9'6''
5. 12' to 12'6''

The recovery assessment committee agreed to fix the maximum girth of logs after field visit to depot on next day, as we are not sure what is the maximum girth of logs that are available in the depot and coming out from the forest.

6. Length of the logs

The recovery assessment committee discussed and agreed to fix the length of logs after a field visit to the depot on next day taking into account length of logs extracted in above defined girth classes. Along with this it was also decided to fix the sizes for sawn timber during the field visit.

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Kinley Tenzin
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Dawa
In-Charge, NRDCL,
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Participants

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7. Tshering Wangchuk, Executive Member, AWBI, Thimphu
8. Kencho Tshering, AFD, AWBI'
9. Karma Wangdi, Timber King
10. Passang, Wood Mizer
11. Jigme Wangchuk, Wood Mizer
12. Sherab Wangchuk, Lucas Mill
13. Namgay, Norwood
14. Steve, Norwood
15. Tashi, G.T Sawmill, Haa, representative of Indian Sawmill
16. Pema Tshewang, Dy. CFO, Paro
17. Kinley Tenzin, NRDCL
18. Dorji Wangdi, FRMD
19. Kuenzang Lhamo, FRMD
20. Nangay Bidha, FRMD
21. Namgay Tenzin, Norwood
22. Dawa, NRDCL, Haa

Annexure IV: Minutes of meeting on timber lot formation and allotment

Meeting of Timber Recovery Assessment

Date: 11/8/2017
Venue: Tsapay Depot, Haa
Time: 9:30 AM
Agenda: Timber lot formation, measurement processes and criteria for timber recovery assessment

Discussion

1. Log Size

The timber recovery assessment committee discussed thoroughly and decided to provide 5 logs each of different girth classes to different sawmills (Indian Sawmill, Timber King, Wood Mizer, Norwood, Lucas Mill). The size of the logs are defined as below in girth and length as below:

Sl. No	Girth	Length
1	3' to 3' 6''	13 (Spruce)
2	5' to 5'6''	15 (Hemlock)
3	7' to 7'6''	13 (Spruce)
4	9'to 9'6''	12 (Spruce)
5	11' 6'' to 12'	7 (Hemlock)

2. Sawn timber Sizes

The timber recovery assessment committee discussed sawn timber sizes to be sawn at different sawmill for assessment. The following common sizes are decided for sawing at each sawmill.

Sl. No	Sizes (inches)
1	5x 4
2	4 x3
3	3x 3
4	3x 2
5	3x1.5
6	2x 1.5
7	12x1.5
8	10 x 1.5
9	8x 1.5
10	7 x 1.5
11	6 x 1.5
12	5 x 1.5

Sl. No	Sizes (inches)
13	12 x 1
14	10 x 1
15	8x 1
16	7 x 1
17	6 x 1
18	5 x 1
19	4 x 1
20	3 x 1
21	2 x 1
22	2 x 0.5
23	2x2
24	1x1

3. Terms and Conditions for Sawing /measurement of sawn timber

Following terms and conditions shall be applicable for sawing and measurement of the sawn timber at each sawmill.

a. Bakals or barks attached to sawn piece of timber shall not be entertained for measurement.
b. All sawmills shall saw minimum of five pieces each of all sizes mentioned above from 5 pieces of logs provided to them.
c. Other sawn timbers should meet the size requirement provided above.
d. If a sawn piece of timber, sawed as a particular size mentioned above but physical measurement exceeds by one or more millimeter, shall be categorized within that size category. For instance, if sawn timbers suppose to be sawed as 5'' x 4'', when physically measured, if measurement exceeds by 1mm or more, shall be categorized with 5'' x 4'' and excess measurement shall not be accounted.

e. If a sawn piece of timber, sawed as a particular size mentioned above but during physical measurement, if the size does not meet the minimum size requirement even by 1mm shall be clubbed with next smaller size and difference between the actual measurement and next smaller size shall not be accounted. For example, if the sawn timber suppose to be sawed as 5'' x 4'', when physically measured, if measurement is in deficit even by 1mm, shall be categorized with 4'' x 3'' or other sizes mentioned above and difference between actual measurement and the size with which a particular piece of sawn timber is clubbed shall not be accounted.

4. Criteria for Assessment

The sawmills shall be assessed based on following parameters

1. Recovery
2. Efficiency
3. Power Consumption
4. Ancillary consumptions
5. Number of operators and helpers
6. Safety features
7. Environmental Impacts
8. Machine cost /affordability
9. Maintenance cost/maintenance services

5. Other conditions

1. The timber recovery assessment committee shall explain all conditions above to sawmill promoters/sawmill owner at the time of assessment.
2. Only assessment committee shall be engaged for assessing the parameters mentioned above including measurement of logs and sawn timber.
3. Any saw millers shall be allowed to observe the process of assessment if they are interested. However, those saw millers shall not interfere the process of sawing or assessment being carried out by assessment committee. They shall be entertained as an observer.

Participants

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Annexure V: List of logs allotted to Sawmills

a) Indian Sawmill

Sl. No	Log No.	Species	Log length	Girth at mid-point	Log volume (cft)
1	4182	Hemlock	15’11’’	5’ 2’’	33.81
2	4193	Hemlock	8’1’’	11’11’’	91.35
3	4105	Spruce	12’3’’	9’2’’	81.91
4	3940	Spruce	13’3’’	7’4’’	56.7
5	4149	Spruce	13’7’’	3’7’’	13.88
	Total				**277.65**

b) LucasMill

Sl. No	Log No.	Species	Log length (ft)	Girth at mid-point	Volume
1	4097	Spruce	12’1”	8’9”	73.62
2	4461	Hemlock	6’10’’	10’7”	60.91
3	4455	Spruce	13’2’’	3’7”	13.45
4	4465	Hemlock	15’2’’	4’10”	28.2
5	4102	Spruce	14’’	7’7”	64.07
	Total				**240.24**

c) TimberKing

Sl. No	Log No.	Species	Log length (ft)	Girth at mi- point	Volume
1	3937	Spruce	11’10”	7’5”	51.7981
2	4453	Spruce	16’2”	3’10”	18.9044
3	4475	Hemlock	15’9”	5’	31.3336
4	4445	Hemlock	7’1”	10’	56.3673
5	4111	Spruce	12’	9’5”	84.6769
	Total				**243.08**

d) Wood-Mizer

Sl. No	Log No.	Species	Log length (ft)	Girth at mid-point	Volume
1	4197	Spruce	10’	9’6”	71.82
2	4478	Hemlock	15’5”	4’7”	25.77
3	4451	Spruce	13’4”	3’7”	13.62
4	4095	Spruce	12’8”	8’2”	67.23
5	4525	Hemlock	7’3”	10’7”	64.62
	Total				**243.06**

e) Norwood

Sl. No	Log No.	Species	Log length (ft)	Girth at mid-point	Volume
1	4452	Spruce	13’5’’	3’4’’	11.86
2	4467	Hemlock	15’4’’	4’6”	24.71
3	4538	Hemlock	7’	10’3’’	58.52
4	3975	Spruce	14’	7’10”	68.36
5	4112	Spruce	11’	8’8”	65.75
	Total				**229.2**

Annexure VI: Summary of percentage of sawn timber produced by different sawmills by log number

a) Indian Sawmill

Sl. No	Log No.	Species	Log length	Girth at mid-point	Log volume (cft)	Sawn volume (cft)	% sawn timber
1	4182	Hemlock	15’11’’	5’ 2’’	33.81	25.97	76.8116
2	4193	Hemlock	8’1’’	11’11’’	91.35	75.25	82.3755
3	4105	Spruce	12’3’’	9’2’’	81.91	71.67	87.4985
4	3940	Spruce	13’3’’	7’4’’	56.7	46.83	82.5926
5	4149	Spruce	13’7’’	3’7’’	13.88	11.75	84.6542
	Total				**277.65**	**231.47**	**83.3675**

b) LucasMill

Sl. No	Log No.	Species	Log length (ft)	Girth at mid point	Log_volume (cft)	Sawn volume (cft)	% sawn timber
1	4097	Spruce	12’1”	8’9”	73.62	52.1	70.7688
2	4461	Hemlock	6’10’’	10’7”	60.91	43.97	72.1885
3	4455	Spruce	13’2’’	3’7”	13.45	7.63	56.7286
4	4465	Hemlock	15’2’’	4’10”	28.2	18.88	66.9504
5	4102	Spruce	14’’	7’7”	64.07	38.47	60.0437
	Total				**240.24**	**161.05**	**67.0371**

c) TimberKing

Sl. No	Log No.	Species	Log length (ft)	Girth at mid point	Log_volume (cft)	Sawn volume (cft)	% sawn timber
1	3937	Spruce	11’10”	7’5”	51.7981	45.43	87.7059
2	4453	Spruce	16’2”	3’10”	18.9044	15.61	82.5734
3	4475	Hemlock	15’9”	5’	31.3336	27.51	87.7971
4	4445	Hemlock	7’1”	10’	56.3673	51.53	91.4183
5	4111	Spruce	12’	9’5”	84.6769	72.12	85.1708
	Total				**243.08**	**212.20**	**87.2964**

d) Wood-Mizer

Sl. No	Log No.	Species	Log length (ft)	Girth at mid point	Log_volume (cft)	Sawn volume (cft)	% sawn timber
1	4197	Spruce	10’	9’6”	71.82	61.36	85.4358
2	4478	Hemlock	15’5”	4’7”	25.77	20.07	77.8813
3	4451	Spruce	13’4”	3’7”	13.62	11.11	81.5712
4	4095	Spruce	12’8”	8’2”	67.23	57.19	85.0662
5	4525	Hemlock	7’3”	10’7”	64.62	61.36	94.9551
	Total				**243.06**	**211.09**	**86.8469**

e) Norwood

Sl. No	Log No.	Species	Log length (ft)	Girth at mid point	Log_volume (cft)	Sawn volume (cft)	% sawn timber
1	4452	Spruce	13’5’’	3’4’’	11.86	8.95	75.4637
2	4467	Hemlock	15’4’’	4’6”	24.71	18.87	76.3658
3	4538	Hemlock	7’	10’3’’	58.52	0	0
4	3975	Spruce	14’	7’10”	68.36	0	0
5	4112	Spruce	11’	8’8”	65.75	0	0
	Total				**229.2**	**27.83**	**76.1006**

Annexure VII: Detail Measurement list of sawn timber by Sawmills

a) Indian Sawmill

Sawn Timber Measurement

Name of the Sawmill: G. T. Sawmill
Proprietor: Tashi
No. of Operators: 5
Location : Hatey Chumpa, Haa

Sawmill Type: Indian Sawmill
Model:
Date:

Sl. No	Log volume (cft)	Log No.	Length				Width (inch)	Thickness (inch)	No. of pieces	Sawn timber volume (cft)
			Feet	Inch	Inch to ft	Total length (ft)				
1	33.81	4182	15	11	0.92	15.92	5	4.0	7	15.47
2		4182	15	11	0.92	15.92	4	3.0	1	1.33
3		4182	15	11	0.92	15.92	3	3.0	1	0.99
4		4182	14		0.00	14.00	8	1.5	1	1.17
5		4182	2		0.00	2.00	7	1.5	1	0.15
6		4182	15	6	0.50	15.50	5	1.5	1	0.81
7		4182	15	11	0.92	15.92	10	1.0	1	1.11
8		4182	15	11	0.92	15.92	8	1.0	1	0.88
9		4182	7	4	0.33	7.33	7	1.0	1	0.36
10		4182	7	1	0.08	7.08	5	1.0	1	0.25
11		4182	5		0.00	5.00	5	1	1	0.17
12		4182	6	8	0.67	6.67	4	1.0	1	0.19
13		4182	7	8	0.67	7.67	4	1.0	1	0.21
14		4182	4	4	0.33	4.33	3	1.0	1	0.09
15		4182	3	7	0.58	3.58	3	1	1	0.07
16		4182	10	8	0.67	10.67	2	1.0	1	0.15
17		4182	7		0.00	7.00	2	1	1	0.10
18		4182	15	11	0.92	15.92	2	1	2	0.44
19		4182	9		0.00	9.00	2	1	1	0.13
20		4182	7	5	0.42	7.42	2	1	1	0.10
21		4182	7	8	0.67	7.67	2	1	1	0.11
22		4182	6		0.00	6.00	2	1	1	0.08
23		4182	7	9	0.75	7.75	2	1	1	0.11
24		4182	6	6	0.50	6.50	2	0.5	1	0.05
25		4182	6	1	0.08	6.08	2	0.5	1	0.04
26		4182	7	2	0.17	7.17	2	0.5	1	0.05
27		4182	8	1	0.08	8.08	2	0.5	1	0.06
28		4182	6	4	0.33	6.33	2	0.5	1	0.04
29		4182	7	6	0.50	7.50	2	0.5	1	0.05
30		4182	5		0.00	5.00	2	0.5	1	0.03

Sl. No	Log volume (cft)	Log No.	Length				Width (inch)	Thickness (inch)	No. of pieces	Sawn timber volume (cft)
			Feet	Inch	Inch to ft	Total length (ft)				
31		4182			0.00	0.00	2	2.0		0.00
32		4182	7	3	0.25	7.25	1	1.0	3	0.15
33		4182	9		0.00	9.00	1	1.0	1	0.06
34		4182	10		0.00	10.00	1	1.0	1	0.07
35		4182	12	6	0.50	12.50	1	1.0	1	0.09
36		4182	15	8	0.67	15.67	5	1.5	1	0.82
37	91.35	4193	8	1	0.08	8.08	5	4.0	9	10.10
38		4193	8	1	0.08	8.08	4	3.0	1	0.67
39		4193	8	1	0.08	8.08	4	3.0	2	1.35
40		4193	8	1	0.08	8.08	3	3.0	1	0.51
41		4193	5	6	0.50	5.50	3	2.0	2	0.46
42		4193	6	2	0.17	6.17	3	2.0	1	0.26
43		4193	7	7	0.58	7.58	3	2.0	1	0.32
44		4193	8	1	0.08	8.08	3	2.0	16	5.39
45		4193	7	0	0.00	7.00	3	2.0	1	0.29
46		4193	6	0	0.00	6.00	3	2.0	1	0.25
47		4193	8	1	0.08	8.08	3	2.0	8	2.69
48		4193	6	0	0.00	6.00	3	1.5	1	0.19
49		4193	8	1	0.08	8.08	3	1.5	4	1.01
50		4193	5	1	0.08	5.08	3	1.5	1	0.16
51		4193	7	10	0.83	7.83	3	1.5	1	0.24
52		4193	8	1	0.08	8.08	3	1.5	1	0.25
53		4193	8	1	0.08	8.08	3	1.5	2	0.51
54		4193	8	1	0.08	8.08	12	1.5	4	4.04
55		4193	8	1	0.08	8.08	12	1.5	3	3.03
56		4193	8	1	0.08	8.08	10	1.5	10	8.42
57		4193	8	1	0.08	8.08	8	1.5	8	5.39
58		4193	8	1	0.08	8.08	6	1.5	1	0.51
59		4193	8	1	0.08	8.08	5	1.5	7	2.95
60		4193	8	1	0.08	8.08	5	1.5	10	4.21
61		4193	8	1	0.08	8.08	4	1.5	3	1.01
62		4193	8	1	0.08	8.08	4	1.5	2	0.67
63		4193	6	8	0.67	6.67	4	1.5	1	0.28
64		4193	8	1	0.08	8.08	12	1.0	1	0.67
65		4193	8	1	0.08	8.08	8	1.0	8	3.59
66		4193	8	1	0.08	8.08	6	1.0	11	3.70
67		4193	8	1	0.08	8.08	6	1.0	2	0.67
68		4193	8	1	0.08	8.08	5	1.0	8	2.25
69		4193	7	10	0.83	7.83	5	1.0	6	1.63
70		4193	8	1	0.08	8.08	5	1.0	2	0.56
71		4193	5	2	0.17	5.17	4	1.0	1	0.14
72		4193	8	1	0.08	8.08	4	1.0	3	0.67

Sl. No	Log volume (cft)	Log No.	Length				Width (inch)	Thickness (inch)	No. of pieces	Sawn timber volume (cft)
			Feet	Inch	Inch to ft	Total length (ft)				
73		4193	3	4	0.33	3.33	4	1.0	1	0.09
74		4193	4	2	0.17	4.17	4	1.0	1	0.12
75		4193	5	6	0.50	5.50	3	1.0	1	0.11
76		4193	4	10	0.83	4.83	3	1.0	1	0.10
77		4193	8	2	0.17	8.17	3	1.0	1	0.17
78		4193	8	1	0.08	8.08	3	1.0	4	0.67
79		4193	8	1	0.08	8.08	3	1.0	2	0.34
80		4193	5	2	0.17	5.17	3	1.0	2	0.22
81		4193	3	7	0.58	3.58	3	1.0	1	0.07
82		4193	4	5	0.42	4.42	3	1.0	1	0.09
83		4193	8	1	0.08	8.08	3	1.0	1	0.17
84		4193	6		0.00	6.00	2	1.0	1	0.08
85		4193	5	4	0.33	5.33	2	1.0	1	0.07
86		4193	8	1	0.08	8.08	2	1.0	5	0.56
87		4193	6	1	0.08	6.08	2	1.0	1	0.08
88		4193	7	9	0.75	7.75	2	1.0	1	0.11
89		4193	4	8	0.67	4.67	2	1.0	1	0.06
90		4193	8	1	0.08	8.08	2	0.5	1	0.06
91		4193	6	2	0.17	6.17	2	0.5	1	0.04
92		4193	8	1	0.08	8.08	2	2.0	7	1.57
93		4193	3	4	0.33	3.33	2	2.0	1	0.09
94		4193	8	1	0.08	8.08	1	1.0	2	0.11
95		4193	6	4	0.33	6.33	1	1.0	1	0.04
96		4193	4	7	0.58	4.58	1	1.0	1	0.03
97		4193	8	1	0.08	8.08	1	1.0	1	0.06
98		4193	5	8	0.67	5.67	1	1.0	1	0.04
99		4193	5	0	0.00	5.00	1	1.0	5	0.17
100		4193	5	4	0.33	5.33	1	1.0	1	0.04
101		4193	5	9	0.75	5.75	1	1.0	1	0.04
102		4193	3	8	0.67	3.67	1	1.0	1	0.03
103		4193	6	0	0.00	6.00	1	1.0	1	0.04
104		4193			0.00	0.00	5	1.5		0.00
105		4193	8	1	0.08	8.08	2	0.5	1	0.06
106		4193	2	9	0.75	2.75	2	0.5	1	0.02
107		4193	4	3	0.25	4.25	3	1	1	0.09
108		4193	5	6	0.50	5.50	3	1	1	0.11
109		4193	5	10	0.83	5.83	2	1	1	0.08
110		4193	7	8	0.67	7.67	2	1	1	0.11
111		4193	5	6	0.50	5.50	2	1	2	0.15
112		4193	3	11	0.92	3.92	2	1	1.0	0.05
113		4193	2		0.00	2.00	2	1	1.0	0.03
114	81.91	4105	12	3	0.25	12.25	5	4.0	27	45.94

Sl. No	Log volume (cft)	Log No.	Length				Width (inch)	Thickness (inch)	No. of pieces	Sawn timber volume (cft)
			Feet	Inch	Inch to ft	Total length (ft)				
115		4105	12	3	0.25	12.25	4	3.0	6	6.13
116		4105	12	3	0.25	12.25	3	2.0	1	0.51
117		4105	8	10	0.83	8.83	3	2.0	2	0.74
118		4105	12	3	0.25	12.25	12	1.5	3	4.59
119		4105	12	3	0.25	12.25	5	1.5	1	0.64
120		4105	12	3	0.25	12.25	4	1.5	1	0.51
121		4105	12	3	0.25	12.25	12	1.0	4	4.08
122		4105	7	3	0.25	7.25	12	1.0	1	0.60
123		4105	5	3	0.25	5.25	10	1.0	1	0.36
124		4105	12	3	0.25	12.25	8	1.0	1	0.68
125		4105	7	3	0.25	7.25	7	1.0	1	0.35
126		4105	12	3	0.25	12.25	4	1.0	6	2.04
127		4105	7	9	0.75	7.75	4	1.0	2	0.43
128		4105	9	8	0.67	9.67	3	1.0	1	0.20
129		4105	9	2	0.17	9.17	3	1.0	1	0.19
130		4105	10	3	0.25	10.25	3	1.0	1	0.21
131		4105	12	3	0.25	12.25	3	1.0	1	0.26
132		4105	12	3	0.25	12.25	2	1.0	6	1.02
133		4105	4	4	0.33	4.33	2	1.0	1	0.06
134		4105	8	6	0.50	8.50	2	1.0	1	0.12
135		4105	7	2	0.17	7.17	2	1.0	1	0.10
136		4105	6	6	0.50	6.50	2	1.0	2	0.18
137		4105	7	5	0.42	7.42	2	1.0	1	0.10
138		4105	6	5	0.42	6.42	2	1.0	1	0.09
139		4105	12	3	0.25	12.25	2	0.5	1	0.09
140		4105	7	2	0.17	7.17	2	0.5	2	0.10
141		4105	5	11	0.92	5.92	2	0.5	4	0.16
142		4105	12	3	0.25	12.25	2	2.0	1	0.34
143		4105	12	3	0.25	12.25	1	1.0	5	0.43
144		4105	7	3	0.25	7.25	1	1.0	1	0.05
145		4105	4	11	0.92	4.92	1	1.0	1	0.03
146		4105	5	5	0.42	5.42	1	1.0	1	0.04
147		4105	6	1	0.08	6.08	1	1.0	1	0.04
148		4105	6	3	0.25	6.25	1	1.0	1	0.04
149		4105	6	4	0.33	6.33	1	1.0	1	0.04
150		4105	7	2	0.17	7.17	1	1.0	1	0.05
151		4105	5	6	0.50	5.50	1	1.0	3	0.11
152	56.7033	3940	13	3	0.25	13.25	5	4.0	11	20.24
153		3940	13	3	0.25	13.25	4	3.0	2	2.21
154		3940	13	3	0.25	13.25	3	3.0	6	4.97
155		3940	13	3	0.25	13.25	3	2.0	1	0.55
156		3940	8	7	0.58	8.58	3	1.5	1	0.27

Sl. No	Log volume (cft)	Log No.	Length				Width (inch)	Thickness (inch)	No. of pieces	Sawn timber volume (cft)
			Feet	Inch	Inch to ft	Total length (ft)				
157		3940	13	3	0.25	13.25	3	1.5	1	0.41
158		3940	13	3	0.25	13.25	7	1.5	5	4.83
159		3940	13	3	0.25	13.25	6	1.5	6	4.97
160		3940	13	3	0.25	13.25	10	1.0	3	2.76
161		3940	13	3	0.25	13.25	8	1.0	1	0.74
162		3940	13	3	0.25	13.25	7	1.0	1	0.64
163		3940	13	3	0.25	13.25	6	1.0	1	0.55
164		3940	6		0.00	6.00	6	1.0	1	0.25
165		3940	13	3	0.25	13.25	3	1.0	4	1.10
166		3940	7		0.00	7.00	3	1.0	1	0.15
167		3940	8	9	0.75	8.75	3	1.0	1	0.18
168		3940	13	3	0.25	13.25	2	1.0	4	0.74
169		3940	6	7	0.58	6.58	2	1.0	1	0.09
170		3940	4	9	0.75	4.75	2	1.0	1	0.07
171		3940	6		0.00	6.00	2	1.0	1	0.08
172		3940	10		0.00	10.00	1	1.0	1	0.07
173		3940	13	3	0.25	13.25	1	1.0	3	0.28
174		3940	6	8	0.67	6.67	1	1.0	1	0.05
175		3940	7	3	0.25	7.25	1	1.0	1	0.05
176		3940	6	1	0.08	6.08	1	1.0	1	0.04
177		3940	7	11	0.92	7.92	2	0.5	1	0.05
178		3940	7	3	0.25	7.25	2	0.5	1	0.05
179		3940	5	4	0.33	5.33	2	0.5	1	0.04
180		3940	6	10	0.83	6.83	2	0.5	1	0.05
181		3940	13	3	0.25	13.25	2	0.5	2	0.18
182		3940	5	7	0.58	5.58	2	0.5	1	0.04
183		3940	4	5	0.42	4.42	4	1.0	1	0.12
184	13.88	4149	13	7	0.58	13.58	5	4.0	3	5.66
185		4149	13	7	0.58	13.58	4	3.0	2	2.26
186		4149	13	7	0.58	13.58	7	1.0	3	1.98
187		4149	7	5	0.42	7.42	7	1.0	1	0.36
188		4149	4	10	0.83	4.83	4	1.0	1	0.13
189		4149	5	11	0.92	5.92	4	1.0	1	0.16
190		4149	7	2	0.17	7.17	4	1.0	1	0.20
191		4149	7	3	0.25	7.25	3	1.0	1	0.15
192		4149	7	1	0.08	7.08	2	1.0	1	0.10
193		4149	13	7	0.58	13.58	2	1.0	1	0.19
194		4149	5	9	0.75	5.75	2	1.0	1	0.08
195		4149	6	2	0.17	6.17	2	1.0	1	0.09
196		4149	13	7	0.58	13.58	1	1.0	2	0.19
197		4149	5		0.00	5.00	1	1.0	1	0.03
198		4149	9		0.00	9.00	1	1.0	1	0.06

Sl. No	Log volume (cft)	Log No.	Length				Width (inch)	Thickness (inch)	No. of pieces	Sawn timber volume (cft)
			Feet	Inch	Inch to ft	Total length (ft)				
199		4149	13	7	0.58	13.58	2	0.5	1	0.09
		Total								**231.46**

Summary

Particulars	Unit	Measurement
Total log volume	cft	277.65
Total sawn timber volume	cft	231.46
Sawn timber percent	%	83.36

b) LucasMill

Sawn Timber Measurement

Name of the Sawmill: Lucky Sawmill
Proprietor: Tenzin Jamba
No. of Operators: 3
Location : Damcho, Haa

Sawmill Type: LucasMill
Model:
Date:

Sl. No	Log volume (cft)	Log No.	Length				Width (inch)	Thickness (inch)	No. of pieces	Sawn timber volume (cft)
			Feet	Inch	Inch to ft	Total length (ft)				
1	73.62	4097	12	1	0.08	12.08	5	4.0	5	8.39
2		4097	12	1	0.08	12.08	4	3.0	4	4.03
3		4097	12	1	0.08	12.08	3	3.0	1	0.76
4		4097	12	1	0.08	12.08	3	2.0	4	2.01
5		4097	10		0.00	10.00	3	2.0	1	0.42
6		4097	5		0.00	5.00	3	2.0	1	0.21
7		4097	9		0.00	9.00	3	2.0	1	0.38
8		4097	12	1	0.08	12.08	8	1.5	13	13.09
9		4097	6		0.00	6.00	8	1.5	1	0.50
10		4097	10		0.00	10.00	8	1.5	1	0.83
11		4097	12	1	0.08	12.08	7	1.5	11	9.69
12		4097	2	1	0.08	2.08	5	1.5	1	0.11
13		4097	9		0.00	9.00	5	1.5	1	0.47
14		4097	12	1	0.08	12.08	4	1.5	5	2.52
15		4097	12	1	0.08	12.08	8	1.0	5	3.36
16		4097	12	1	0.08	12.08	7	1.0	5	2.94
17		4097	6		0.00	6.00	7	1.0	1	0.29

Sl. No	Log volume (cft)	Log No.	Length				Width (inch)	Thickness (inch)	No. of pieces	Sawn timber volume (cft)
			Feet	Inch	Inch to ft	Total length (ft)				
18		4097	4	5	0.42	4.42	5	1	1	0.15
19		4097	7	8	0.67	7.67	5	1.0	1	0.27
20		4097	10	1	0.08	10.08	5	1.0	1	0.35
21		4097	2		0.00	2.00	4	1.0	1	0.06
22		4097	6		0.00	6.00	4	1.0	1	0.17
23		4097	5	6	0.50	5.50	3	1.0	1	0.11
24		4097	7	7	0.58	7.58	2	1.0	1	0.11
25		4097	12	1	0.08	12.08	2	1.0	3	0.50
26		4097	3		0.00	3.00	2	1.0	1	0.04
27		4097	3	11	0.92	3.92	2	1.0	1	0.05
28		4097	6		0.00	6.00	2	1.0	1	0.08
29		4097	12	1	0.08	12.08	1	1.0	2	0.17
30		4097	8	3	0.25	8.25	1	1.0	1	0.06
31	60.91	4461	6	10	0.83	6.83	5	4.0	3	2.85
32		4461	6	10	0.83	6.83	4	3.0	3	1.71
33		4461	5	6	0.50	5.50	4	3.0	1	0.46
34		4461	6	6	0.50	6.50	4	3.0	2	1.08
35		4461	6	10	0.83	6.83	3	3.0	6	2.56
36		4461	5	7	0.58	5.58	3	3.0	1	0.35
37		4461	6	10	0.83	6.83	3	1.5	6	1.28
38		4461	6	10	0.83	6.83	2	1.5	6	0.85
39		4461	6	10	0.83	6.83	10	1.5	15	10.68
40		4461	5		0.00	5.00	10	1.5	1	0.52
41		4461	6	10	0.83	6.83	6	1.5	11	4.70
42		4461	6	10	0.83	6.83	5	1.5	10	3.56
43		4461	6	10	0.83	6.83	10	1.0	11	5.22
44		4461	6	10	0.83	6.83	7	1.0	1	0.33
45		4461	6	10	0.83	6.83	6	1.0	7	1.99
46		4461	6	10	0.83	6.83	5	1.0	5	1.19
47		4461	4	6	0.50	4.50	4	1.0	1	0.13
48		4461	6	10	0.83	6.83	3	1.0	5	0.71
49		4461	4		0.00	4.00	3	1.0	1	0.08
50		4461	6	10	0.83	6.83	2	1.0	8	0.76
51		4461	4	5	0.42	4.42	2	1.0	1	0.06
52		4461	6	10	0.83	6.83	2	0.5	6	0.28
53		4461	6	10	0.83	6.83	2	2.0	12	2.28
54		4461	6	10	0.83	6.83	1	1.0	7	0.33
55	13.45	4455	13	2	0.17	13.17	5	4.0	3	5.49
56		4455	13	2	0.17	13.17	4	1.5	1	0.55
57		4455	13	2	0.17	13.17	5	1.0	1	0.46
58		4455	13	2	0.17	13.17	4	1.0	3	1.10
59		4455	6	1	0.08	6.08	1	1.0	1	0.04

Sl. No	Log volume (cft)	Log No.	Length				Width (inch)	Thickness (inch)	No. of pieces	Sawn timber volume (cft)
			Feet	Inch	Inch to ft	Total length (ft)				
60	28.20	4465	15	2	0.17	15.17	5	4.0	6	12.64
61		4465	15	2	0.17	15.17	3	2.0	3	1.90
62		4465	11		0.00	11.00	2	1.5	1	0.23
63		4465	12	8	0.67	12.67	5	1.5	1	0.66
64		4465	13		0.00	13.00	4	1.5	1	0.54
65		4465	15	2	0.17	15.17	5	1.0	2	1.05
66		4465	15	2	0.17	15.17	4	1.0	3	1.26
67		4465	15	2	0.17	15.17	2	1.0	2	0.42
68		4465	12	10	0.83	12.83	2	1.0	1	0.18
69	64.07	4102	14		0.00	14.00	5	4.0	16	31.11
70		4102	14		0.00	14.00	4	3.0	3	3.50
71		4102	9		0.00	9.00	4	3.0	1	0.75
72		4102	5		0.00	5.00	4	1.5	1	0.21
73		4102	14		0.00	14.00	5	1.0	2	0.97
74		4102	9	5	0.42	9.42	5	1.0	1	0.33
75		4102	8	6	0.50	8.50	4	1.0	1	0.24
76		4102	14		0.00	14.00	3	1.0	2	0.58
77		4102	14		0.00	14.00	2	1.0	1	0.19
78		4102	14		0.00	14.00	2	2.0	1	0.39
79		4102	7		0.00	7.00	2	2.0	1	0.19
	240.24				Total					161.05

Summary

Particulars	Unit	Measurement
Total log volume	cft	240.24
Total sawn timber volume	cft	161.05
Sawn timber percent	%	67.03542

c) TimberKing

Sawn Timber Measurement

Name of the Sawmill: Drugyal Mobile Sawmill
Proprietor: Karma Wangdi
No. of Operators: 4
Location : Shari, Paro

Sawmill Type: TimberKing
Model:
Date:

Sl. No	Log volume (cft)	Log No.	Length				Width (inch)	Thickness (inch)	No. of pieces	Sawn timber volume (cft)
			Feet	Inch	Inch to ft	Total length(ft)				
1	51.80	3937	11	10	0.83	11.83	5	4.0	10	16.44
2		3937	11	10	0.83	11.83	4	3.0	9	8.88
3		3937	11	10	0.83	11.83	3	3.0	7	5.18
4		3937	11	10	0.83	11.83	3	2.0	7	3.45
5		3937	11	10	0.83	11.83	3	1.5	8	2.96
6		3937	11	10	0.83	11.83	8	1.5	1	0.99
7		3937	8	6	0.50	8.50	8	1.5	1	0.71
8		3937	11	10	0.83	11.83	6	1.5	1	0.74
9		3937	3	4	0.33	3.33	6	1.5	1	0.21
10		3937	11	10	0.83	11.83	5	1.5	4	2.47
11		3937	11	10	0.83	11.83	6	1.0	2	0.99
12		3937	4	7	0.58	4.58	6	1.0	1	0.19
13		3937	11	10	0.83	11.83	4	1.0	1	0.33
14		3937	11	10	0.83	11.83	2	1	6	0.99
15		3937	11	10	0.83	11.83	2	0.5	5	0.41
16		3937	5	0	0.00	5.00	2	0.5	1	0.03
17		3937	6	10	0.83	6.83	2	2.0	1	0.19
18		3937	11	10	0.83	11.83	1	1.0	3	0.25
19		3937	8	1	0.08	8.08	1	1.0	1	0.06
20	18.90	4453	16	2	0.17	16.17	12	1.5	5	10.10
21		4453	16	2	0.17	16.17	10	1.5	1	1.68
22		4453	16	2	0.17	16.17	8	1.5	1	1.35
23		4453	16	2	0.17	16.17	7	1.5	1	1.18
24		4453	16	2	0.17	16.17	2	0.5	8	0.90
25		4453	10		0.00	10.00	2	0.5	2	0.14
26		4453	10	8	0.67	10.67	2	0.5	2	0.15
27		4453	16	2	0.17	16.17	1	1.0	1	0.11
28	31.33	4475	15	9	0.75	15.75	4	3.0	12	15.75
29		4475	5	1	0.08	5.08	3	1.5	1	0.16
30		4475	10	8	0.67	10.67	6	1.5	1	0.67
31		4475	12	8	0.67	12.67	10	1.0	3	2.64
32		4475	13	0	0.00	13.00	6	1.0	1	0.54
33		4475	11	6	0.50	11.50	6	1.0	1	0.48

Sl. No	Log volume (cft)	Log No.	Length				Width (inch)	Thickness (inch)	No. of pieces	Sawn timber volume (cft)
			Feet	Inch	Inch to ft	Total length(ft)				
34		4475	15	9	0.75	15.75	3	1.0	7	2.30
35		4475	5		0.00	5.00	3	1.0	1	0.10
36		4475	7	4	0.33	7.33	3	1.0	1	0.15
37		4475	12		0.00	12.00	3	1.0	1	0.25
38		4475	6		0.00	6.00	2	1.0	1	0.08
39		4475	7		0.00	7.00	2	1.0	1	0.10
40		4475	15	9	0.75	15.75	2	0.5	5	0.55
41		4475	15	9	0.75	15.75	2	2.0	3	1.31
42		4475	10	9	0.75	10.75	1	1.0	1	0.07
43		4475	4	5	0.42	4.42	1	1.0	1	0.03
44		4475	2.00	7	0.58	2.58	5	1	1.0	0.09
45		4475	3.00	1	0.08	3.08	5	1	1.0	0.11
46		4475	6.00	0	0.00	6.00	5	1	1.0	0.21
47		4475	4.00	2	0.17	4.17	3	2	1.0	0.17
48		4475	4.00	10	0.83	4.83	3	2	2.0	0.40
49		4475	3.00	5	0.42	3.42	3	2	1.0	0.14
50		4475	4.00	0	0.00	4.00	2	1	1.0	0.06
51		4475	3.00	4	0.33	3.33	2	1	5.0	0.23
52		4475	6.00	0	0.00	6.00	2	1	1.0	0.08
53		4475	4.00	7	0.58	4.58	2	1	1.0	0.06
54		4475	3.00	7	0.58	3.58	2	1	1.0	0.05
55		4475	4.00	5	0.42	4.42	4	1	1.0	0.12
56		4475	5.00	8	0.67	5.67	4	1	1.0	0.16
57		4475	4.00	10	0.83	4.83	6	1	1.0	0.20
58		4475	3.00	4	0.33	3.33	8	1	1.0	0.19
59		4475	4	4	0.33	4.33	1	1.0	1	0.03
60		4475	3		0.00	3.00	1	1.0	1	0.02
61	56.37	4445	7	1	0.08	7.08	4	3.0	6	3.54
62		4445	7	0	0.00	7.00	4	3.0	2	1.17
63		4445	7	1	0.08	7.08	3	3.0	1	0.44
64		4445	7	0	0.00	7.00	3	3.0	1	0.44
65		4445	7	1	0.08	7.08	3	2.0	3	0.89
66		4445	7	1	0.08	7.08	3	1.5	4	0.89
67		4445	7	1	0.08	7.08	2	1.5	4	0.59
68		4445	7	1	0.08	7.08	10	1.5	6	4.43
69		4445	7	1	0.08	7.08	8	1.5	6	3.54
70		4445	7	1	0.08	7.08	7	1.5	9	4.65
71		4445	7	1	0.08	7.08	5	1.5	11	4.06
72		4445	7	1	0.08	7.08	4	1.5	5	1.48
73		4445	7	1	0.08	7.08	12	1.0	8	4.72
74		4445	7	1	0.08	7.08	10	1.0	12	5.90
75		4445	7	1	0.08	7.08	8	1.0	8	3.15

Sl. No	Log volume (cft)	Log No.	Length				Width (inch)	Thickness (inch)	No. of pieces	Sawn timber volume (cft)
			Feet	Inch	Inch to ft	Total length(ft)				
76		4445	7	1	0.08	7.08	7	1.0	8	2.75
77		4445	7	1	0.08	7.08	6	1.0	12	3.54
78		4445	7	1	0.08	7.08	5	1.0	6	1.48
79		4445	7	1	0.08	7.08	4	1.0	5	0.98
80		4445	7	0	0.00	7.00	4	1.0	1	0.19
81		4445	7	1	0.08	7.08	2	1.0	7	0.69
82		4445	7	1	0.08	7.08	2	0.5	4	0.20
83		4445	7	0	0.00	7.00	2	0.5	1	0.05
84		4445	5	10	0.83	5.83	2	0.5	5	0.20
85		4445	7	1	0.08	7.08	2	2.0	7	1.38
86		4445	7	1	0.08	7.08	1	1.0	2	0.10
87		4445	5		0.00	5.00	1	1.0	1	0.03
88		4445	5	8	0.67	5.67	1	1.0	1	0.04
89	84.68	4111	12		0.00	12.00	5	4.0	25	41.67
90		4111	12		0.00	12.00	4	3.0	6	6.00
91		4111	8	3	0.25	8.25	4	3.0	1	0.69
92		4111	12		0.00	12.00	3	3.0	5	3.75
93		4111	8		0.00	8.00	3	3.0	1	0.50
94		4111	3	8	0.67	3.67	3	2.0	1	0.15
95		4111	12		0.00	12.00	12	1.5	4	6.00
96		4111	9		0.00	9.00	3	1.5	1	0.28
97		4111	3		0.00	3.00	3	1.5	1	0.09
98		4111	8	10	0.83	8.83	3	1.5	1	0.28
99		4111	8	9	0.75	8.75	3	1.5	1	0.27
100		4111	3		0.00	3.00	2	1.5	1	0.06
101		4111	8	5	0.42	8.42	2	1.5	1	0.18
102		4111	12		0.00	12.00	5	1.5	5	3.13
103		4111	12		0.00	12.00	4	1.5	3	1.50
104		4111	9	1	0.08	9.08	4	1.5	1	0.38
105		4111	9	2	0.17	9.17	4	1.5	1	0.38
106		4111	12		0.00	12.00	12	1.0	5	5.00
107		4111	12		0.00	12.00	5	1.0	4	1.67
108		4111	12		0.00	12.00	1	1.0	1	0.08
109		4111	9		0.00	9.00	1	1.0	1	0.06
	243.08					**Total**				**212.18**

Summary

Particulars	Unit	Measurement
Total log volume	cft	243.08
Total sawn timber volume	cft	212.18
Sawn timber percent	%	87.289

d) Wood-Mizer

Sawn Timber Measurement

Name of the Sawmill: Gaphel Sawmill
Proprietor: Passang
No. of Operators: 4
Location : Gidakom, Thimphu

Sawmill Type: Wood-Mizer
Model:
Date:

Sl. No	Log volume (cft)	Log No.	Length				Width (inch)	Thickness (inch)	No. of pieces	Sawn timber volume (cft)
			Feet	Inch	Inch to ft	Total length(ft)				
1	71.82	4197	10		0.00	10.00	5	4.0	9	12.50
2		4197	10		0.00	10.00	4	3.0	14	11.67
3		4197	10		0.00	10.00	3	3.0	10	6.25
4		4197	10		0.00	10.00	3	2.0	9	3.75
5		4197	7	1	0.08	7.08	3	2.0	1	0.30
6		4197	6		0.00	6.00	3	2.0	1	0.25
7		4197	10		0.00	10.00	3	1.5	4	1.25
8		4197	8		0.00	8.00	3	1.5	1	0.25
9		4197	9		0.00	9.00	3	1.5	1	0.28
10		4197	10		0.00	10.00	12	1.5	5	6.25
11		4197	9		0.00	9.00	12	1.5	1	1.13
12		4197	10		0.00	10.00	10	1.5	3	3.13
13		4197	10		0.00	10.00	8	1.5	4	3.33
14		4197	10		0.00	10.00	5	1.5	4	2.08
15		4197	10		0.00	10.00	4	1.5	3	1.25
16		4197	8		0.00	8.00	8	1.0	1	0.44
17		4197	10		0.00	10.00	7	1.0	5	2.43
18		4197	10		0.00	10.00	5	1	2	0.69
19		4197	10		0.00	10.00	4	1.0	3	0.83
20		4197	10		0.00	10.00	3	1.0	2	0.42
21		4197	7		0.00	7.00	3	1.0	1	0.15
22		4197	6		0.00	6.00	3	1.0	1	0.13
23		4197	10		0.00	10.00	2	1.0	4	0.56
24		4197	3		0.00	3.00	2	1.0	2	0.08
25		4197	7		0.00	7.00	2	1.0	1	0.10
26		4197	8		0.00	8.00	2	0.5	1	0.06
27		4197	10		0.00	10.00	2	2.0	1	0.28
28		4197	4		0.00	4.00	2	2.0	1	0.11
29		4197	10		0.00	10.00	1	1.0	17	1.18
30		4197	7		0.00	7.00	1	1.0	1	0.05
31		4197	5		0.00	5.00	1	1.0	2	0.07
32		4197	4		0.00	4.00	1	1.0	3	0.08
33		4197	7		0.00	7.00	1	1.0	1	0.05

Sl. No	Log volume (cft)	Log No.	Length				Width (inch)	Thickness (inch)	No. of pieces	Sawn timber volume (cft)
			Feet	Inch	Inch to ft	Total length(ft)				
34	25.77	4478	15	5	0.42	15.42	3	2.0	1	0.64
35		4478	15	5	0.42	15.42	3	1.5	1	0.48
36		4478	15	5	0.42	15.42	2	1.5	2	0.64
37		4478	15	5	0.42	15.42	8	1.5	7	8.99
38		4478	15	5	0.42	15.42	5	1.5	1	0.80
39		4478	15	5	0.42	15.42	8	1.0	3	2.57
40		4478	15	5	0.42	15.42	7	1.0	1	0.75
41		4478	15	5	0.42	15.42	6	1.0	1	0.64
42		4478	15	5	0.42	15.42	5	1.0	1	0.54
43		4478	13	8	0.67	13.67	5	1.0	1	0.47
44		4478	13		0.00	13.00	5	1.0	1	0.45
45		4478	11	11	0.92	11.92	4	1.0	1	0.33
46		4478	15	5	0.42	15.42	3	1.0	1	0.32
47		4478	14		0.00	14.00	3	1.0	2	0.58
48		4478	7		0.00	7.00	3	1.0	1	0.15
49		4478	3		0.00	3.00	2	1.0	1	0.04
50		4478	2		0.00	2.00	2	1.0	1	0.03
51		4478	14		0.00	14.00	2	1.0	1	0.19
52		4478	10		0.00	10.00	2	0.5	1	0.07
53		4478	15	5	0.42	15.42	1	1.0	9	0.96
54		4478	7		0.00	7.00	1	1.0	1	0.05
55		4478	3		0.00	3.00	1	1.0	1	0.02
56		4478	4		0.00	4.00	1	1.0	1	0.03
57		4478	5		0.00	5.00	1	1.0	1	0.03
58		4478	9		0.00	9.00	1	1.0	1	0.06
59		4478	11		0.00	11.00	1	1.0	1	0.08
60		4478	12		0.00	12.00	1	1.0	1	0.08
61		4478	6		0.00	6.00	1	1.0	1	0.04
62		4478	2		0.00	2.00	1	1.0	1	0.01
63	67.23	4095	12	8	0.67	12.67	3	1.5	5	1.98
64		4095	2	9	0.75	2.75	3	1.5	1	0.09
65		4095	12	8	0.67	12.67	10	1.5	12	15.83
66		4095	12	8	0.67	12.67	8	1.5	1	1.06
67		4095	4	1	0.08	4.08	8	1.5	1	0.34
68		4095	12	8	0.67	12.67	7	1.5	4	3.69
69		4095	12	8	0.67	12.67	6	1.5	6	4.75
70		4095	12	8	0.67	12.67	5	1.5	12	7.92
71		4095	12	8	0.67	12.67	4	1.5	1	0.53
72		4095	10		0.00	10.00	4	1.5	2	0.83
73		4095	11		0.00	11.00	4	1.5	1	0.46
74		4095	12	8	0.67	12.67	12	1.0	1	1.06
75		4095	12	8	0.67	12.67	10	1.0	8	7.04

Sl. No	Log volume (cft)	Log No.	Length				Width (inch)	Thickness (inch)	No. of pieces	Sawn timber volume (cft)
			Feet	Inch	Inch to ft	Total length(ft)				
76		4095	12	8	0.67	12.67	8	1.0	5	3.52
77		4095	10		0.00	10.00	8	1.0	1	0.56
78		4095	6	10	0.83	6.83	8	1.0	1	0.38
79		4095	12	8	0.67	12.67	5	1.0	1	0.44
80		4095	12	8	0.67	12.67	3	1.0	4	1.06
81		4095	5		0.00	5.00	3	1.0	1	0.10
82		4095	8	6	0.50	8.50	3	1.0	1	0.18
83		4095	12	8	0.67	12.67	2	1.0	4	0.70
84		4095	8	1	0.08	8.08	2	1.0	1	0.11
85		4095	7	9	0.75	7.75	2	1.0	1	0.11
86		4095	5	6	0.50	5.50	2	1.0	1	0.08
87		4095	5		0.00	5.00	2	1.0	1	0.07
88		4095	6		0.00	6.00	2	1.0	3	0.25
89		4095	3		0.00	3.00	2	1.0	2	0.08
90		4095	2		0.00	2.00	2	1.0	1	0.03
91		4095	12	8	0.67	12.67	2	2.0	4	1.41
92		4095	6	10	0.83	6.83	2	2.0	1	0.19
93		4095	7	3	0.25	7.25	2	2.0	1	0.20
94		4095	10		0.00	10.00	2	2.0	1	0.28
95		4095	9	10	0.83	9.83	2	2.0	1	0.27
96		4095	8	3	0.25	8.25	2	2.0	1	0.23
97		4095	4		0.00	4.00	2	2.0	1	0.11
98		4095	12	8	0.67	12.67	1	1.0	11	0.97
99		4095	9	6	0.50	9.50	1	1.0	1	0.07
100		4095	3	2	0.17	3.17	1	1.0	1	0.02
101		4095	8	8	0.67	8.67	1	1.0	1	0.06
102		4095	6	3	0.25	6.25	1	1.0	1	0.04
103		4095	2	4	0.33	2.33	1	1.0	1	0.02
104		4095	9		0.00	9.00	1	1.0	1	0.06
105		4095	4	7	0.58	4.58	1	1.0	1	0.03
106	64.62	4525	7	3	0.25	7.25	5	4.0	30	30.21
107		4525	7	3	0.25	7.25	4	3.0	6	3.63
108		4525	6		0.00	6.00	4	3.0	1	0.50
109		4525	7	3	0.25	7.25	3	2.0	8	2.42
110		4525	3	2	0.17	3.17	3	2.0	1	0.13
111		4525	5		0.00	5.00	3	2.0	2	0.42
112		4525	6		0.00	6.00	3	2.0	1	0.25
113		4525	7	3	0.25	7.25	3	1.5	1	0.23
114		4525	7	3	0.25	7.25	2	1.5	1	0.15
115		4525	2		0.00	2.00	2	1.5	1	0.04
116		4525	7	3	0.25	7.25	8	1.5	1	0.60
117		4525	7	3	0.25	7.25	7	1.5	1	0.53

Sl. No	Log volume (cft)	Log No.	Length				Width (inch)	Thickness (inch)	No. of pieces	Sawn timber volume (cft)
			Feet	Inch	Inch to ft	Total length(ft)				
118		4525	7	3	0.25	7.25	5	1.5	5	1.89
119		4525	7	3	0.25	7.25	4	1.5	3	0.91
120		4525	4		0.00	4.00	4	1.5	2	0.33
121		4525	7	3	0.25	7.25	12	1.0	4	2.42
122		4525	7	3	0.25	7.25	7	1.0	2	0.70
123		4525	5	9	0.75	5.75	7	1.0	1	0.28
124		4525	7	3	0.25	7.25	6	1.0	3	0.91
125		4525	4	10	0.83	4.83	6	1.0	1	0.20
126		4525	7	3	0.25	7.25	5	1.0	26	6.55
127		4525	5		0.00	5.00	5	1.0	3	0.52
128		4525	3		0.00	3.00	5	1.0	2	0.21
129		4525	6		0.00	6.00	5	1.0	2	0.42
130		4525	6	7	0.58	6.58	5	1.0	1	0.23
131		4525	7	3	0.25	7.25	4	1.0	3	0.60
132		4525	5		0.00	5.00	4	1.0	2	0.28
133		4525	2		0.00	2.00	4	1.0	2	0.11
134		4525	5	6	0.50	5.50	4	1.0	2	0.31
135		4525	7	3	0.25	7.25	3	1.0	5	0.76
136		4525	5		0.00	5.00	3	1.0	3	0.31
137		4525	3		0.00	3.00	3	1.0	1	0.06
138		4525	6		0.00	6.00	3	1.0	1	0.13
139		4525	7	3	0.25	7.25	2	1.0	7	0.70
140		4525	4	5	0.42	4.42	2	1.0	3	0.18
141		4525	3		0.00	3.00	2	1.0	2	0.08
142		4525	5		0.00	5.00	2	1.0	4	0.28
143		4525	3	9	0.75	3.75	2	1.0	1	0.05
144		4525	4		0.00	4.00	2	1.0	3	0.17
145		4525	6	6	0.50	6.50	2	1.0	1	0.09
146		4525	6		0.00	6.00	2	1.0	2	0.17
147		4525	2		0.00	2.00	2	1.0	1	0.03
148		4525	7	3	0.25	7.25	2	0.5	4	0.20
149		4525	5		0.00	5.00	2	0.5	2	0.07
150		4525	7	3	0.25	7.25	2	2.0	1	0.20
151		4525	3		0.00	3.00	2	2.0	1	0.08
152		4525	7	3	0.25	7.25	1	1.0	7	0.35
153		4525	5		0.00	5.00	1	1.0	3	0.10
154		4525	2		0.00	2.00	1	1.0	1	0.01
155		4525	4		0.00	4.00	1	1.0	3	0.08
156		4525	3		0.00	3.00	1	1.0	4	0.08
157		4525	6		0.00	6.00	1	1.0	3	0.13
158		4525	5	6	0.50	5.50	1	1.0	1	0.04
159		4525	6	3	0.25	6.25	1	1.0	1	0.04

Sl. No	Log volume (cft)	Log No.	Length				Width (inch)	Thickness (inch)	No. of pieces	Sawn timber volume (cft)
			Feet	Inch	Inch to ft	Total length(ft)				
160		4525	5	7	0.58	5.58	1	1.0	1	1.00
161	13.62	4451	13	4	0.33	13.33	8	1.5	6	6.67
162		4451	11	9	0.75	11.75	6	1.5	1	0.73
163		4451	8		0.00	8.00	8	1.0	1	0.44
164		4451	13	4	0.33	13.33	7	1.0	1	0.65
165		4451	8		0.00	8.00	6	1.0	1	0.33
166		4451	13	4	0.33	13.33	5	1.0	2	0.93
167		4451	8		0.00	8.00	5	1.0	1	0.28
168		4451	5	4	0.33	5.33	3	1.0	2	0.22
169		4451	13	4	0.33	13.33	1	1.0	6	0.56
170		4451	12		0.00	12.00	1	1.0	2	0.17
171		4451	8		0.00	8.00	1	1.0	2	0.11
172		4451	3		0.00	3.00	1	1.0	1	0.02
	243.06					**Total**				**211.09**

Summary

Particulars	Unit	Measurement
Total log volume	cft	243.06
Total sawn timber volume	cft	211.09
Sawn timber percent	%	86.8471

e) Norwood

Sawn Timber Measurement

Name of the Sawmill: Namgay Wood Industry
Proprietor: Tshering Wangchuk
No. of Operators: 2
Location : Dawakha, Paro

Sawmill Type: Norwood
Model:
Date:

Sl. No	Log volume (cft)	Log No.	Length				Width (inch)	Thickness (inch)	No. of pieces	Sawn timber volume (cft)
			Feet	Inch	Inch to ft	Total length (ft)				
1	24.71	4467	15	4	0.33	15.33	5	4.0	3	6.39
2		4467	15	4	0.33	15.33	4	3.0	2	2.56
3		4467	15	4	0.33	15.33	3	3.0	3	2.88
4		4467	10	8	0.67	10.67	3	3.0	1	0.67
5		4467	15	4	0.33	15.33	3	2.0	3	1.92
6		4467	11	2	0.17	11.17	3	2.0	1	0.47

Sl. No	Log volume (cft)	Log No.	Length				Width (inch)	Thickness (inch)	No. of pieces	Sawn timber volume (cft)
			Feet	Inch	Inch to ft	Total length (ft)				
7		4467	15	4	0.33	15.33	7	1.0	1	0.75
8		4467	9	8	0.67	9.67	7	1.0	1	0.47
9		4467	3	6	0.50	3.50	6	1.0	1	0.15
10		4467	11	0	0.00	11.00	6	1.0	1	0.46
11		4467	9	6	0.50	9.50	2	1	1	0.13
12		4467	11	0	0.00	11.00	2	1.0	1	0.15
13		4467	9	0	0.00	9.00	2	1.0	1	0.13
14		4467	6	5	0.42	6.42	2	1.0	1	0.09
15		4467	15	4	0.33	15.33	2	1	1	0.21
16		4467	14	0	0.00	14.00	2	1.0	1	0.19
17		4467	11	3	0.25	11.25	2	1	1	0.16
18		4467	15	4	0.33	15.33	2	1	1	0.11
19		4467	9	10	0.83	9.83	2	1	1	0.07
20		4467	9	7	0.58	9.58	2	1	1	0.07
21		4467	15	4	0.33	15.33	2	2	1	0.43
22		4467	15	4	0.33	15.33	1	1	3	0.32
23		4467	9	2	0.17	9.17	1	1	1	0.06
24		4467	4	5	0.42	4.42	1	1.0	1	0.03
25		4467	6	0	0.00	6.00	1	1.0	1	0.04
37	11.49	4452	13	5	0.42	13.42	5	4.0	2	3.73
38		4452	13	5	0.42	13.42	3	2.0	3	1.68
39		4452	13	5	0.42	13.42	8	1.0	1	0.75
40		4452	13	5	0.42	13.42	7	1.0	1	0.65
41		4452	6	9	0.75	6.75	6	1.0	2	0.56
42		4452	10	5	0.42	10.42	6	1.0	1	0.43
43		4452	3	8	0.67	3.67	4	1.0	2	0.20
44		4452	2	3	0.25	2.25	3	1.0	1	0.05
45		4452	13	5	0.42	13.42	2	1.0	1	0.19
46		4452	13	5	0.42	13.42	2	0.5	5	0.47
47		4452	13	5	0.42	13.42	1	1.0	2	0.19
48		4452	6	0	0.00	6.00	1	1.0	1	0.04
49		4452	3	9	0.75	3.75	1	1.0	1	0.03
	36.20					**Total**				**27.83**

Summary

Particulars	Unit	Measurement
Total log volume	cft	36.20
Total sawn timber volume	cft	27.83
Sawn timber percent	%	76.87429