



## Economic Loss of Timber Caused by Over Stumps and Defects in Community Forests Terai Nepal

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### Abstract

The economic loss of timber caused by over stumps and defects is an essential issue in forest science but study regarding this is very limited in Nepal. Thus, this research was objectively conducted to assess the volume of timber loss and associated monetary loss caused by over stumps and defects in logs and reason behind this. Three community forests namely Deurali, Jay Durga and Raniphanta community forests were selected for this research. Total enumeration was done so 375 stumps and 224 defected logs were measured from 15 March to 15 April, 2019. The height and diameter at the butt end were measured using simple tape and D-tape respectively. Additionally, the length and diameter of defects in log was recorded. Total thirty key informant interviews and three focus group discussions were organized to assess the major causes of over stumps and defects. The timber volume loss caused by over stumps was calculated using cylindrical volume formula and volume loss caused by defect was calculated using formula, i.e. gross volume - net volume. The price of wood was collected from community forest to calculate the monetary value of timber loss. The principal component analysis was applied to assess the major causes of over stumps and defect in log. The highest total volume loss was recorded around 15.217 m<sup>3</sup> (28.49%) caused by over stumps and out of this, it was 53.41 m<sup>3</sup> timber loss in Deurali community forest. The loss due to defects in tree was ranged from 128.57 to 284.21 m<sup>3</sup> in the community forests. The monetary value of loss caused by over stump was US\$ 6971.14 of *Shorea robusta* in Deurali community forest and it was US\$ 8100.52 because of defect. The principal component analysis showed that use of saw and axe for felling the trees in the community forests was considered as highest factor of over stump and diseases and over mature trees were key factors of wood defect. The research will be useful for policy makers and scientific community to monitor the timber loss.

**Keywords:** Stump height; Defects; Decay; Buttrace; Disease.

## 1. Introduction

Forest resource is the main home of diverse biology. The primary forests have different canopy layers and various structure which supports to make the nature beautiful and conserve the biological diversity (Dronova, 2017; Mosseler *et al.*, 2003). The forests offer three types of functions in the world; they are production, biological and environmental functions (Cardinale *et al.*, 2012). The biological diversity is maintained through biological and environmental functions (Fischer *et al.*, 2006; Isbell *et al.*, 2011). The production functions are the foundation of social and economic function which is maintained by the forest's growth. The old growth forests are significant to perform the biological and environmental function (Lindenmayer and Noss, 2006) though slow but may be insignificant for production function.

The old growth forests are quite unable to produce the quality timber and other forest products. The old growth forests and over mature trees loss their capacity of diameter, height and crown increment and ultimately the basal area, volume and biomass (Greaves *et al.*, 2013). Furthermore, ultimate consequence is quality loss. Such forests dominated by over mature and old trees are unable to cope with the defects and recover. So, the timber loss is vital reason of defects (FRI, 2017). Different types of disease, decay and insect attack are observed in the old growth forest. The loss of timber leads to economic loss as a whole (DoF, 2014).

On the other hand, timber loss was very serious challenge because of neglecting the use of advance techniques and technology of harvesting felling site. The leaving of over stumps after felling the trees causes another significant volume and economic loss in the forest (Nikooy and Amozadeh, 2014). So, the production function of the forest is affected. The problem of over stumps and defects is seriously observed particularly in developing countries (Gajaseni and Jordan, 1990) including Nepal. One of the important reasons is ignorance to apply the advance tools, techniques and technology of felling, sectioning and logging (Mehta, 2011). India, Bhutan, Pakistan including Nepal have been losing huge volume of timber and amount of money as well because of the defects in timber as well as

leaving over stumps in felling site (Shrestha, 2000;2017). However, such researches are very limited. Thus, this research was objectively conducted to assess the volume of timber loss caused by high stumps defects and its monetary value as well as associated factors casing over stumps and defects.

## 2. Materials and Methods

**Study Area:** Three community forests where felling practice was done were selected as the study site. These were Raniphanta community forest of Kailali district, Jaya Durga community forest of Banke District and Deurali community forest of Bardiya district (Figure 1). The major vegetation are Sal (*Shorea Robusta*), Asna (*Termenalia alata*), Jamun (*Syzygium cumini*), Sissoo (*Dalbergia sissoo*), Dabdabe (*Garuga pinnata*), Dhauti (*Anogeissus latifolius*), Haldu (*Adina cardifolia*), Mauwa (*Engelhardtia spicata*), Kusum (*Cleistocalyx operculata*), *Termenalia bellirica* (Barro), and *Careya arborea* (Kumbhi) in the forest. The harvesting was done in 3.36, 0.86 and 4.38 ha in Raniphanta CF, Jaya Durga CF and Deurali Fulbari CF respectively (DFO, 2019a-a;2019a-b;2019a-c).

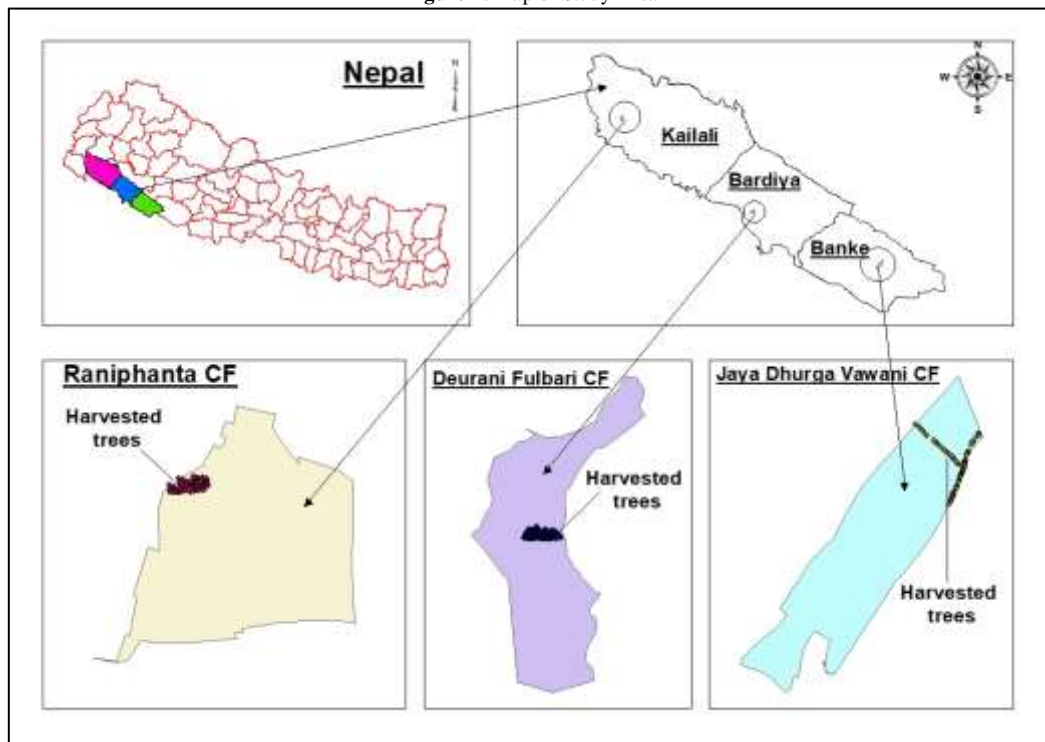
**Sampling and measurement:** Total enumeration was applied (Du *et al.*, 2008; Kothari, 2004) to collect data related to timber loss caused by over stumps and defect in the forests. Specifically, total 375 stumps and 224 defected logs were measured. The stump height and diameter at the butt end were measured using simple tape and D-tape respectively and noted according to species. In addition, the length and diameter of defects in the log was recorded (Table 1).

**Table-1.** Information about Selected Community Forest

Communiy forest	Total area ha	Harvested compartment	Harvested area ha	No. of stump measured	No. of defected logs measured
Raniphanta CF	227.82	Compartment 4	3.36	103	81
Jaya Durga CF	488.90	Fire line area	0.86	98	45
Deurali CF	301.72	Compartment 1	4.38	174	98

Source: field data

**Figure-1.** Map of Study Area



**Key informant interview:** Total 30 key informants were selected to conduct key informant interview to identify the major causes of timber loss caused by over stumps and defects. The key informants were user committee members, forest staff and labour head.

**Focus group discussion:** Total three focus group discussions were organized in the community forest to know the major causes of timber loss caused by over stumps and defects. The participants belonged to forest users, forestry professional and loggers.

**Observation:** The researchers visited 15 March to 15 April, 2019 to collect the data regarding this study. In addition, the researcher collected the price of timber from the community forest to calculate monetary value of timber loss caused by over stumps and defects.

**Calculation and analysis;** Over stumps = stump height-30cm (MoFE, 2019)

Timber volume loss caused by over stumps =  $\pi D^2/4 \times h$  (Whereas  $\pi$  value is 3.14, D is the diameter of stump at butt end and h is height above 30 cm.

Timber volume loss caused by defects = Gross volume- Net volume

Defected volume = Gross volume - net volume

Monetary loss = Price of timber × timber volume loss caused by over stumps and defects

(Chaturbedi and Khanna, 1994)

Cause and effect analysis: Statistically, the principle component analysis was done to find major causes of timber loss caused by over stumps and defects.

### 3. Results

**Timber loss due to over stump and defects:** Huge quantity of timber loss caused by over stump and defects was recorded at felling series in community forest. Total 94 trees were felled leaving over stump and the dominant one was of the most commercially valuable species *Shorea robusta* (Sal). The timber volume loss caused by over stump (VLOS) was 11.834 m<sup>3</sup> in Deurali community forest while the volume loss caused by defect (VLCD) was around 29.59 m<sup>3</sup>. However, these losses were least in Jay Durga community forest (Table 2).

Table-2. Loss of timber caused by over stump and defects

Plant Species	Deurali CF			Jay Durga CF			Raniphanta CF		
	N	VLOS (m <sup>3</sup> )	VLCD (m <sup>3</sup> )	N	VLOS (m <sup>3</sup> )	VLCD (m <sup>3</sup> )	N	VLOS (m <sup>3</sup> )	VLCD (m <sup>3</sup> )
<i>Shorea robusta</i>	69	11.834	29.59	13	0.689	10.3	98	9.8	18
<i>Dalbergia sisso</i>	1	0.053	0	0	0	0	0	0	0
<i>Dillenia pentagyna</i>	0	0	0	2	0.045	0	0	0	0
<i>Ficus Bengalensis</i>	1	0.06	0	0	0	0	0	0	0
<i>Termenalia alata</i>	4	0.503	0.13	0	0	0.07	5	6.3	0.38
<i>Syzygium Cumini</i>	2	0.172	0.22	1	0.243	0	0	0	0.76
<i>Anogeissus latifolia</i>	6	0.499	0.28	4	0.071	0.66	0	0	0
<i>Adina cardifolia</i>	1	0.254	0	0	0	0.59	0	0	3.23
<i>Schleichera oleosa</i>	10	1.842	0.51	0	0	0	0	0	0.52
<i>Termenalia bellirica</i>	0	0	0	0	0	0.06	0	0	0
<i>Engelhardtia spicata</i>	0	0	0	0	0	0.07	0	0	0.11
<i>Careya arborea</i>	0	0	0	0	0	0.02	0	0	0

(Note: VLOS: Volume loss due to over stumps and VLCD: Volume loss caused by defects)

**Total volume loss due to over stump and defects:** Loss due to over stump and defects varied in the felling site of community forests. The highest total volume loss was recorded around 15.217 m<sup>3</sup> (28.49%) caused by over stumps out of 53.41 m<sup>3</sup> in Deurali community forest. This was the highest around 16.34 m<sup>3</sup> (22.92%) out of 71.29 m<sup>3</sup> timber volume loss in Raniphanta community forest. The loss due to defects in tree was ranged from 128.57 to 284.21 in the community forests (Table 3).

Table-3. Total volume loss in community forests

Detail	Deurali CF	Jay Durga CF	Raniphanta CF	Remarks
Gross trees volume of over stump m <sup>3</sup>	53.41	5.52	71.29	Parenthesis () indicate the percentage timber loss caused by over stump & defects
Loss caused by over stump	15.217 (28.49 %)	1.048 (18.98 %)	16.34 (22.92 %)	
Gross volume of defected trees m <sup>3</sup>	209.45	128.57	284.21	
Defected total volume	30.73(14.67 %)	11.77 (9.15 %)	23.32 (8.20 %)	

**Monetary Loss due to defects:** The monetary value of timber loss caused by over stump and defects was very at felled sites in community forests. Total monetary value of timber loss was US\$ 24166.60 in the community forests. The dominating loss was estimated of most commercially valuable species *Shorea robusta* in these community forests. The monetary value of timber loss caused by over stump was US\$ 6971.14 of *Shorea robusta* in Deurali community forest and it was US\$8100.52 because of defect (Table 4).

Table-4. Monetary loss caused by over stumps and defects

spp (value in us\$)	deurali cf		jay durga cf		raniphanta cf	
	loss: over stump	loss: defect	loss: over stump	loss: defect	loss: over stump	loss: defect
<i>Shorea robusta</i>	6971.14	8100.52	35.01	3121.8	3981.52	163.51
<i>Dalbergia sisso</i>	12.78	0	0	0	0	0
<i>Dillenia pentagyna</i>	0	0	5.05	0	0	0
<i>Ficus bengalensis</i>	5.98	0	0	0	0	0
<i>Termenalia alata</i>	19.57	20.68	0	12.69	1182.41	52.46
<i>Syzygium Cumini</i>	27.14	34.8	57.64	0	0	4.53
<i>Anogeissus latifolius</i>	8.47	26.15	1.87	69.06	0	0

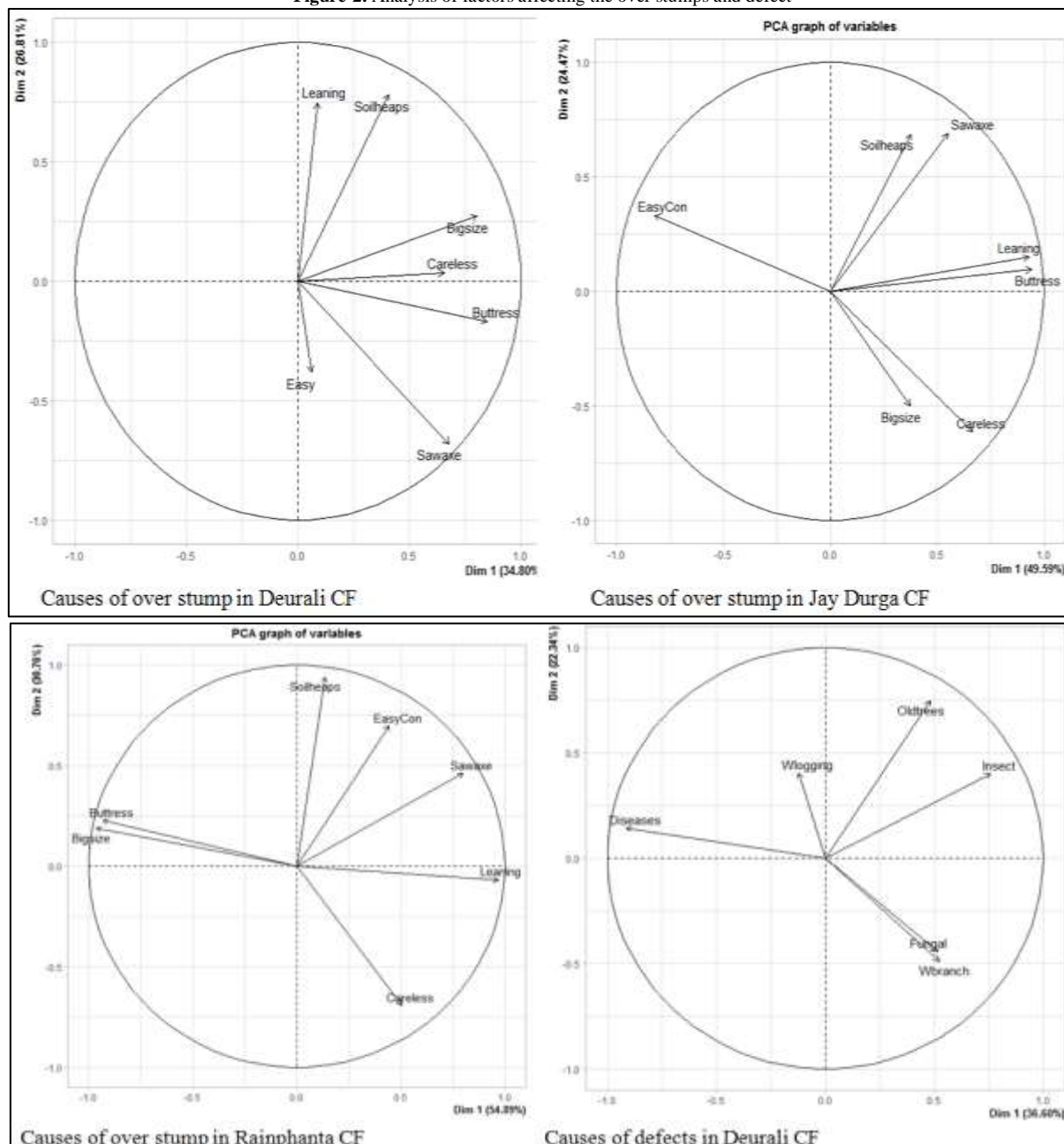
<i>Adina cardifolia</i>	39.64	0	0	101.34	0	8.65
<i>Schleichera oleosa</i>	22.93	47.8	0	0	0	9
<i>Termenalia bellirica</i>	0	0	0	6.54	0	0
<i>Engelhardtia spicata</i>	0	0	0	6.72	0	8.12
<i>Careya arborea</i>	0	0	0	1.08	0	0
Total	7107.65	8229.95	99.57	3319.23	5163.93	246.27

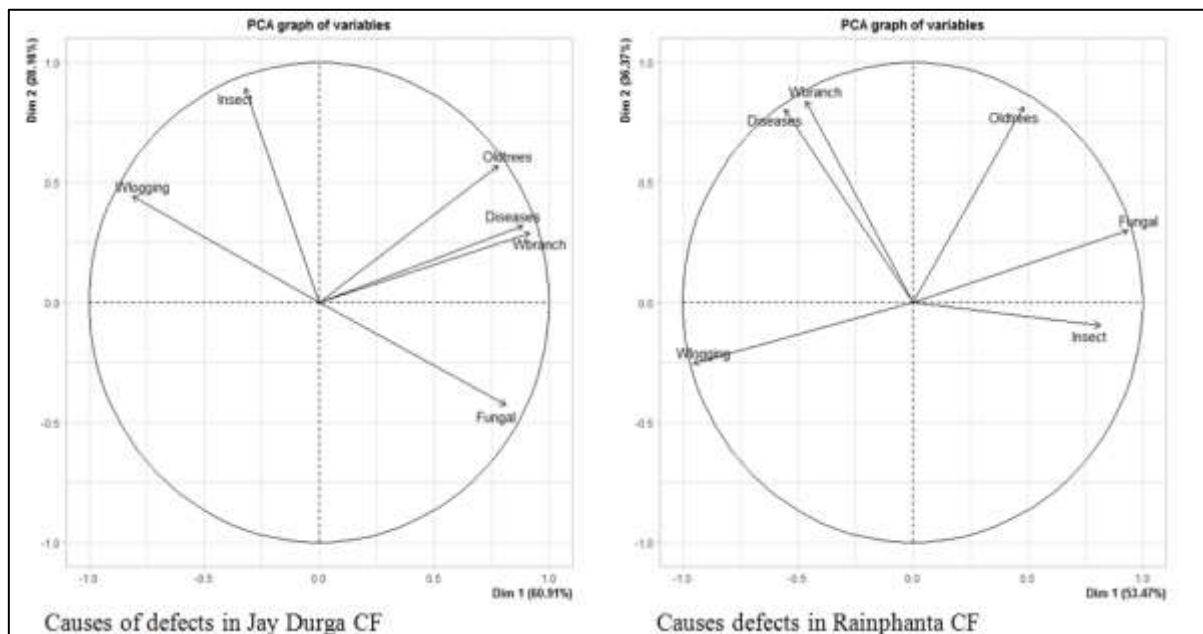
**Causes of over stumps and defects at felling in community forests:** Several factors were affecting timber loss caused by over stump and defects. In fact, total 7 factors were recorded to cause over stump at felling site. The principal component analysis showed that use of saw and axe for felling trees in community forests was ranked as the highest influencing factor of over stump and other factors were buttress at bottom and leaning of tree (Figure 2).

On the other hand, over all six factors were considered as the timber loss caused by defects in the community forests. These factors were diseased trees, water logging at felling site, insect, water entering through wounded branch of tree, fungus and insects. Out of this, the most influencing factor was diseases and over mature trees, though other factors were also highly affecting the quality of the timber (Figure 2).

(Note: Leaning: leaning of tree, Soilheaps: soil heap near tree, Bigsize: Trees with large diameter, Careless: careless ness of labour, Buttress: buttress at lower stump, sawaxe: use of saw & axe for felling, Easycon: easy and convenient to fell, Diseases: disease affected tree, Wlogging: trees in water logging areas, Old trees: over mature trees, Insect: trees affected by insects, Fungal: trees affected due to fungus, Wbranch: Water enters through wound in branch)

Figure-2. Analysis of factors affecting the over stumps and defect





#### 4. Discussions

The loss of timber and its quality is ultimately related to quantity loss its monetary value and also associated causes. The findings showed that timber loss caused by over stumps ranged from 5.52 to 71.29 m<sup>3</sup> in the community forest. This loss was 128.57 m<sup>3</sup> to 284.21 m<sup>3</sup> at 1 ha felling site in community forest. The study done by Nikooy and Amozadeh (2014) showed that the timber loss caused by over stump was around 0.02691 m<sup>3</sup>. The over stump after felling contributes huge quantity of wood waste as a whole (Nilsson *et al.*, 2015). In fact, the butt end part and associated part of wood qualitatively is very good but huge loss was recorded at harvesting site (Winkler, 1997). One of the major reasons may unskilled labour (Murphy and Buse, 1984; Nilsson *et al.*, 2015). The percentage wood loss caused by over stump ranged 6.5-8.5% of the total stem volume (Winkler, 1997). These studies are supportive to our finding. Another study done by Gundimeda (2001) showed that, the timber loss caused by over stump in the forest was about 10-15% and there were several causes associated with this. One of the major causes was the use of axe and saw. Our finding is quite similar with this finding. Another study done by Atkinson and Gundimeda (2006) showed that, around 10% wood was left as stump at felling site. Generally, labours feel easy and comfortable to fell the trees leaving over stump but it accumulates huge timber loss in total volume (Troockenbrodt *et al.*, 2002).

The loss in log volume was caused by use of traditional saw and axe to fell the tree. The consequence is timber loss and similar finding was reported by Vanderberg (2002) stating that improvement and adaptation of advance harvesting tools and techniques would be useful to save the timber loss. Another study done by Noack (1995) showed that around 4.6% loss in timber volume was caused by over stumps, 5.2% due to buttress, 10.4% due to stem off-cuts etc., so the huge monetary loss as well. Over stumps and buttress with large sized diameter were serious causes of timber loss and the resultant effect is on monetary value (Gerwing *et al.*, 1996). Another cause was employment of unskilled labour for felling and sectioning work (Brotoisworo, 1991; Uhl *et al.*, 1997). These studies are quite supportive for our findings; the reason might be application and adoption of similar harvesting techniques and tools.

Similarly, the timber loss caused by defect ranged from 128.57 to 284.21 m<sup>3</sup> in the community forests. Old and over mature large sized trees, diseases, injured branches and water entering into it, water logging and insect/fungal attack were listed as the key causes of defect and timber loss. Subedi (2012), showed that decaying wood was one of the major causes of timber quality and quantity loss. The study done by Kafley (2017) showed that logs on the ground affected by the fungus and diseases and stocks in Teria and Churia were over 120 years old with large size which resulted the timber loss and associated monetary loss as well. In addition, he emphasized that the pilferage, rotting, washed away by floods, burnt were the major causes of timber quality and quantity loss (Kafley, 2017).

The resultant effect of the over stumps and defect was the monetary loss. More specific, over stumps left in the forest and defects lead around US\$ 24166.60 in total monetary loss in the community forests. The dominating loss was recorded of valuable species *Shorea robusta* which value was around US\$ 6971.14 caused by over stumps while US\$8100.52 because of defect in Deurali community forest. In fact, the research done by Boston and Dysart (2000) showed that improvements recovery regarding over stumps and defect could be useful to save huge financial loss. Another study done by Sah *et al.* (2004) stated that the timber loss and its monetary value was about 30 % less in total. The reasons behind this may be over stumps, defects in old trees, unskilled and poor skill of felling techniques. The quality loss in log leads to monetary loss of the timber Gillian (2013). These are matching logics with our research findings.

There were several reasons behind these factors of timber loss caused by over stumps and defects. Some important causes were use of saw and axe for felling the trees, buttress and leaning of over stumps in the community forests. Meanwhile, diseased trees, water logging at felling site, insect, water entering through wounded branch, fungus and insects were recorded as the major influencing factors of defect to lower the quality of timber. Several

studies support to our findings. Study done by Donovan and Nicholls (2003) stated that defects resulted to affect diameter, length, width and thickness of the log which were the chain effect to reduce the overall timber quality and quantity. The timber quality is the alternative options of timber business and consumers' choice (Nyrud *et al.*, 2008). Another study showed that 10-15% timber losses were caused by defects at felling sites (Vanderberg, 2002) which ultimately result to monetary loss (Lowell *et al.*, 2010; Nordmark, 2005). The research findings in our work added more evidence for timber loss caused by over stumps and defects were enough. The quality loss of timber interlinked with market price and consumers' demand (Lewis and Hartley, 2005; Lindenmayer and Noss, 2006).

## 5. Conclusion and Recommendation

Over stumps and defects cause the major loss in timber volume and its quality as well in community forests. The ultimate result of these losses was the monetary loss in total. There were several causes of over stumps which were use of traditional saw and axe for felling, buttress and leaning of trees in the community forests. Moreover, diseased trees, water logging at felling site, insect, water entering through wounded branch, fungus and insects were defect which cause the loss the timber quantity and quality. It is recommended that, these losses can be reduced through application of power chain saw and employing the skilled manpower and careful stocking and piling of logs in the log yard. Further study is essential related to loss caused by over stumps and defect. Such works would be useful for scientific community and policy makers to plan in harvesting yard.

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