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Q-Factor is a Useful Guide for Selection Silviculture on Nepal's Community Forests

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Abstract

There is growing interest by forest users, government forestry officers and policy makers on maximising forest goods and livelihood provisions from community forestry in a sustainable manner. However the way several mature community forests are currently managed based on selection, e.g. negative thinning and crown thinning is questionable as it results to decline in forest stock, timber quality and regeneration. To assist forest users in managing their community forests, an action research has been implemented in Kavre and Lamjung to manage planted Pine (*Pinus spp.*) and naturally-regenerated Sal (*Shorea robusta*) through selection system. This paper describes what is q-factor and its relevance for sustainable community forest management in Nepal. The simple guideline for selection system introduced to 30 community forest users groups in six sites are presented for wider adoption and policy recommendation.

Keywords: Forest goods and services, livelihoods, regeneration, stand structure, sustainable forest management

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1. Introduction

The ongoing campaign in Nepal for scientific forest management (SFM) in Nepal is now challenging the community forestry sector to implement silviculture systems in the management of community forests. There is little examples of silviculture systems at work on community forests that are efficient both at increasing timber production and rate of regeneration. This paper presents a selection silviculture system guided by q-factor, diameter class limit and target basal areas as a promising management system for a considerable areas of community forests.

Community forests in Nepal to date has an area of about 1.8 million hectares (ha) managed by 19,361 community forest users groups (DoF, 2015). The area of community forests represents about a third of the countries forest cover of 5.96 million ha (DFRS, 2015). The State of Nepal's Forest 2015 reported a national average growing stock of 165 m^3/ha where high mountains and high himal region having the highest growing stock of 225 m^3/ha while middle mountains region the lowest growing stock of 124 m^3/ha (DFRS, 2015). The average tree density is 430 stems per ha where 67% of these stem are small pole (10-20 cm diameter at breast height DBH), 18% are large pole (20-30 cm DBH), and 15% saw log/ timber (>30 cm DBH). The diameter class distribution from this national forestry outlook suggests that a management system is needed to be in place so that growth and vigour of small poles are promoted when saw logs are harvested. A selection-based silviculture system is generally applicable for such forest structure and management objectives.

Community forests are the main source for subsistence needs of timber, fuelwood, fodder and leaf litter by majority of the rural population in Nepal. Community forest management is undergoing a level of redefinition particularly with regards to efficiently increasing production of forest products to improve forest-based livelihood and efficiently regenerating healthy forests. Cedamon *et al.* (2017) in their rapid silviculture appraisal found that selection system and shelterwood systems are silviculture systems preferred by community forest users. These silviculture systems appeal to forest users because of the potentials of planting fodder trees and grasses, non-timber forest products (NTFPs), and medicinal and aromatic plants (MAPs) on the forests after treatments. SFM is now a concept being promoted by the Department of Forests (DoFs) for sustainable use of and management of forests. However, community forests silviculture practices are yet at early stages of trials and some silviculture practices confusing to forest users although.

The Scientific Forest Management Guideline 2015 (DoF, 2015) suggests clear felling, selection system and shelterwood as silviculture systems that may be applied on a community forest but the guideline only provide detailed practice guideline for shelterwood system. In support of the Government of Nepal's campaign on '*forestry for prosperity*' through the scientific forest management, the ACIAR EnLiFT Project initiated a participatory action research (PAR) to investigate forest and people responses to different silviculture systems. This paper describes why selection system is a promising management system for many community forests and how this can be implemented. A simple implementation guideline is provided as used in the EnLiFT silviculture Pine forest and Sal forest demonstration works Kavre and Lamjung districts, respectively.

2. Rationale of Selection System on Community Forests

The decision to practice any silvicultural system is primarily based on combination of factors including silvicultural characteristics of species, current forest stand structure and diameter distribution and forest management objectives. For implementation of selection silviculture the following three components has to be taken into consideration: residual stocking, diameter class limit and target diameter distribution. But what is selection silviculture? Smith *et al.* (1997) define **selection silviculture** as silviculture programs that are used to manage multi-age[4] stand where a system of tree selection for residual trees is employed for harvesting and in establishing and developing of regeneration. Smith *et al.* (1997) and Helms (1998) described that in selection system, mature timber is harvested either as single scattered trees or in small groups at short intervals to open growing space for regeneration and these cuttings are repeated indefinitely.

Implementing selection systems requires an understanding of the current forest structure and a target future structure that will support the needs of forest users. Generally Nepal's forests are composed of natural forest and plantations. Natural forests have multi-age age or multi-age although some may have attained even-age stand structure. But many plantations too, which are expected to have even-aged stand structure has developed into multi-age age or at least three crown classes. An insight into the forest structure in Nepal can be described based on the diameter distribution from the State of Nepal's Forest 2015 (DFRS, 2015). This report estimated seedling (<1.3 m height) frequency of 10,095 sph, small saplings (≥1.3 m height, < 5 cm DBH) of 1,045 sph, large saplings (5-10 cm DBH) of 426 sph, small poles (10-20 cm DBH) 287 sph, large pole (20-30 cm DBH) 79 sph, small saw log (30-50 cm DBH) 46 sph and large saw log (≥ 50 cm DBH) of 18 sph. This forest structure is confirmed by few case studies including Cedamon *et al.* (2017) and Awasthi *et al*. (2015). The current stand structure of community forests in Nepal has been achieved through harvesting based on ad hoc selection and sometimes high grading creating openings on the stand allowing natural regeneration to occur.

Community forests in Nepal have been a major for timber, firewood, fodder and leaf litter by millions of rural people. While these forest products are derived by forest users for their subsistent needs, many community forest groups aspires to utilize timber for commercial purposes to drive economic development of the group but retaining a significant forest cover on the stand. The current silviculture practice however is not effective in supplying timber huge enough for driving forest based enterprises and inefficient in developing healthy regeneration. Silviculture practice on community forests therefore has to change if forests users are to increase timber supply and managed stand openings for better and healthy regeneration.

Selection system is an alternative silviculture system for community forests in Nepal that has great potential for increasing supply of timber from current stand at the same time maintaining forest cover and promoting healthy regeneration on newly opened spaces. Larsen (1995) argued that selection system maintains a stable complex forest structure through efficient biogeochemical cycle determined through releases of open spaces for regeneration. Managing and maintaining multi-age stand is now a priority worldwide due to complex societal needs and due to inherently long term nature of forest management, forest should be managed to be able to resist local disturbances and global environmental and climate changes (O'Hara, 2014).

4 The term multi-age is adopted instead of the term uneven age following O'Hara (2014) to include two-age stand which are common in some community forests in Nepal.

Selection systems are generally classed into two broad groups – single tree selection and group selection. While group or strip selection may be suitable for some community forests, single tree selection has been implemented in many community forests though in ad-hoc basis. Therefore aim of this paper is to provide a more scientific and technical guidance into the single tree selection silviculture to increase timber supply and achieve efficient regeneration establishment and improve health and quality of residual and new trees.

3. DBq Approach for Single Tree Selection System on Nepal's Community Forest

As means of organizing stand treatments or operations for tending, harvesting and re-establishing new forests (regeneration), silviculture systems provide means for maintaining or achieving a desired stand structure and that for multi-aged stand selection silviculture is widely applied. A number of approaches for managing or achieving a multi-age stand but the widely used are DBq approach, plenter system, allocation by stand density index, and leaf area allocation (O'Hara and Gersonde, 2004). Stand density index and leaf area allocation are technically complicated perhaps beyond forest capability. The plenter system on the other hand is also technically complicated because of the requirement to at least know the standing timber volume (which should be maintained over long term period) and growth rates so that harvest volume is equal to growth (equilibrium). The DBq approach which builds upon decisions on upper diameter class for which a number of trees has to be retained (D), a desired basal area (B) and a q-factor (q). Q factor which ranges from 1.2 to 2.0, represents the frequency of the trees resembling and inverse J curve or an inverse exponential function. A q factor of 2 means that the a particular diameter class is twice as many as the next larger diameter class while a q factor of 1 represents equal distribution of trees across diameter classes or represented by a flat line. Smith *et al.* (1997) described that a stable equilibrium can be achieve by DBq approach by maintaining a diameter distribution defined by DBq after harvest or mortality. DBq approach has been proven by the EnLiFT Project to be easily understood and implemented by forest users in Nepal because diameter distribution and target diameter limits are readily available information. A routine of calculations is necessary to obtain the residual stocking for DBq. The first step in this calculation determination of target basal area and maximum diameter at breast height for residual trees. A target basal area of 30 m^2 has been widely used in selection system and is adopted for by the EnLiFT Project as suitable for community forests in Nepal. It is to be noted however that many community forests has basal areas <30 m^2 (Cedamon *et al.,* 2017), the aim therefore for selection system is basal area increase from high quality trees. The rapid silviculture appraisal conducted by Cedamon *et al.* (2017) revealed that the diameter limits for residual trees on community forests ranges from 40 to 50 cm (though a few trees larger than 50 cm may present and protected as mother trees). Once an appropriate diameter limit and basal area for the community forest are determined, the next step is to choose a K value from Table 1 for q factors 1.1 – 1.6 and range of diameter class limit calculated by Cancino and Gadow (2002). The residual stocking for the largest diameter class is obtained by dividing the target basal area by the K value corresponding for the desired Q factor and maximum diameter, e.g. the residual stocking for 35-40 cm DBH class for q-factor of 1.2 is 53 trees per ha (thp) (30/0.567). The residual stocking for the next lower DBH class is obtained by multiplying the stocking of the next larger diameter class with the desired Q factor, e.g. the stocking for 30-35 cm DBH class is 63 (52.91 x 1.2).

Table 1. K values for range of q-factors and diameter limits based on Cancino and Gadow (2002).

Maximum DBH (cm)	Number of classes	Q factor					
		1.1	1.2	1.3	1.4	1.5	1.6
40	8	0.475	0.567	0.684	0.829	1.011	1.237
45	9	0.681	0.840	1.048	1.320	1.675	2.139
50	10	0.945	1.204	1.558	2.044	2.709	3.618

Following Cancino and Gadow (2002) the DBq distributions for basal areas of 30 $m^2$and 40 m^2, diameter limits of 40, 45 and 50 and for q factors 1.2 to 1.6 are provided in Figure 1 (please see related ideal stocking table in Appendix 1). Although the choice of a q-factor depends in species and site (Smith *et al.,* 1997), Figure 1 can provide some guidance on choosing a q-factor appropriate for a community forest. It is evident that lower q factors, e.g. 1.2 would result to higher stocking trees in the largest diameter limits similarly but a lower stocking required in the lowest diameter class resulting to a relatively flatter inverse J curve. Therefore, when forest management is aimed for a more frequent cutting or a shorter cutting cycle a lower q factor may seem to be an appropriate choice. The decision on maximum diameter limit is dependent on the current stocking of large trees where more diameter will diameter classes will require higher stocking for larger trees, i.e. <40 cm DBH. For example, the stocking requirement for residual in <35 cm DBH is 91 tph, 79 tph and 53 tph for diameter class limits of 45-50 cm, 40-45 cm, and 35-40 cm, respectively. The frequency however of trees above <40 cm is generally low for many community forests and therefore having a higher diameter class limit is almost unachievable for of these forests. An aim for retaining higher number of larger trees will mean an extremely low harvest of sawlogs. A diameter class limit of 35-40 cm seemed to be a compromise of ensuring timber harvests as well as maintaining forest cover. As expected, the effect of higher basal means a proportionate increase of about 33% on stocking across diameter classes. While seedlings may be naturally available in some forest types particularly Sal forests, some dense forests like Pine plantation may have low natural regeneration with exceptions to those that are affected by frequent fires. For forest with extremely regeneration, the ideal stocking for diameter class 0-5 cm will serve as a guide for minimum number of seedlings that may be required for planting in areas opened after harvesting.

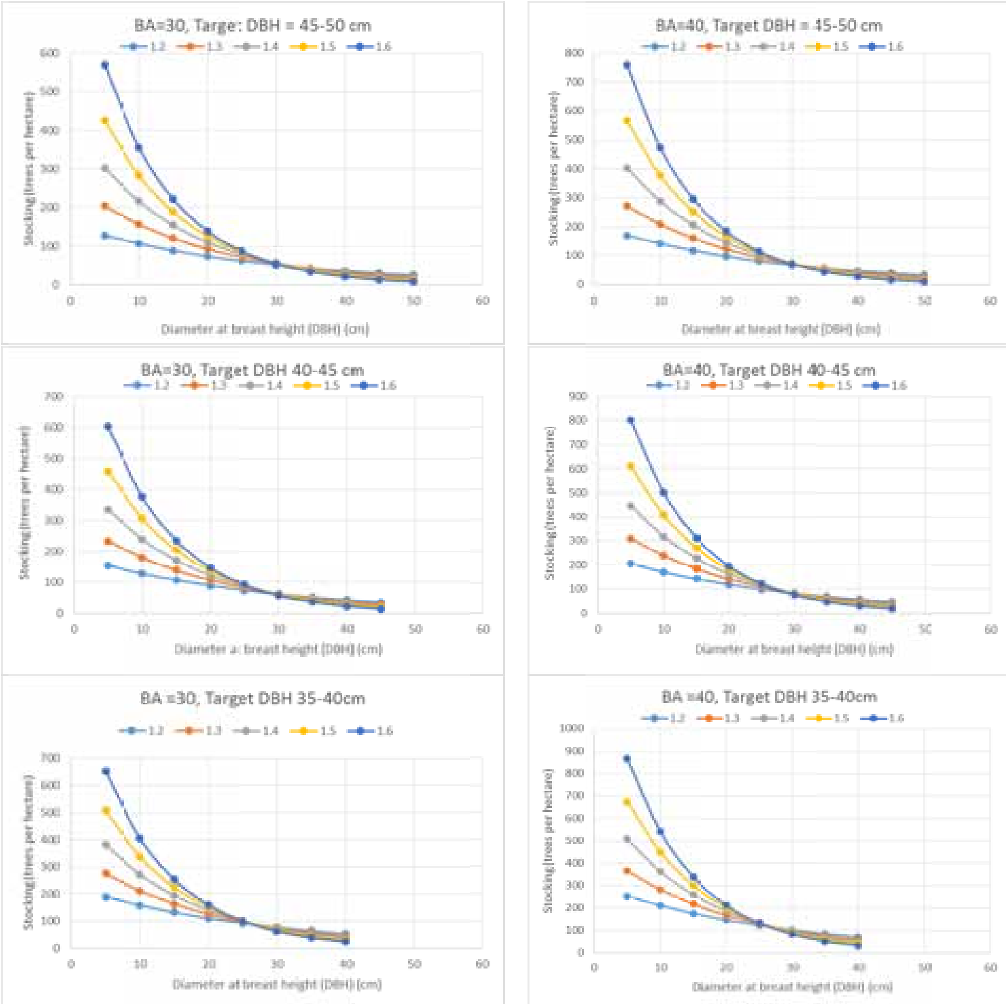

Figure 1. Ideal stocking distribution of a 1-hectare forest based on DBq for basal area 30m^2 and 40m^2 for 40-50cmDBH limits and q-factors 1.2 to 1.6.

4. Selection Silviculture Trials in Nepal

Examples from the EnLiFT Project silviculture demonstration plots are now provided to show how single tree selection silviculture can be implemented. The first step in the implementation of any silviculture system is to obtain information on the existing stand structure and diameter distribution of the forest to be treated. This required an inventory to be carried on the demo plot where it was carried out by the members of the forest users groups after a hands-on training was provided by EnLiFT. Then, consultations in a form of a forest field day with the forest user groups and the executive committee where conducted to present the inventory and decide for the silviculture treatments to be carried. During the consultation, a proposed silviculture regime was presented using graphs of the current and proposed stand stocking based on DBq approach.

A q-factor of 1.2 and 1.3 was respectively proposed for single tree selection system for timber production and single tree selection system for conversion of the current stand into a timber-fodder forest garden.

Example of application of DBq regime for Chapani Pine Forest (Chaubas, Kavre)

The Chapani Community Forest is a 83 ha mix *Pinus wallachiana* (Gobre Salla) and *Pinus patula* (Patte Salla) forest planted in the early 1980s managed by 117 households located in Chaubas, Kavre district (Nepal Australia Community Resource Management and Livelihoods Project, 2006). Chapani forest was established through the Australian Forestry Project which initial aim was generally to reforest the denuded hills in Nepal providing villagers with timber, fuelwood and fodder. The forest provides it forest users' need for timber, fuelwood, leaf litters and grasses. Additionally, the forest also sells a small amount of timber to the Chaubas Sawmill of which it is a component of the forest comprising the sawmill board.

A small portion of the forest has been thinned at around 8-10 years old but after since then forestry operation has been dominated mainly with regular (yearly) small volume of harvest of fuelwood and timber generally guided by an extremely conservative annual allowable cut. Grasses and leaf litter are regularly collected in the forests generally by women but they often compete for good quality grasses due to closed forest canopy. The Chapani forest user group (FUG) is in consensus that forest management should improve to increase harvest volumes as well as to increase grass growth in open spaces.

From the forest inventory conducted in the plot, the sizes of trees on the demo plot before treatment was found to range from 10 cm to 55 cm where the highest stocking is observed at DBH class 20-25 cm at a stocking of 136 trees per hectare (Figure 2 supplemented in Table 2) with declining stocking from this DBH class. The low stocking in over 40 cm DBH classes are attributed to negative selection regime where only the dead, dying, disease and deformed trees are harvested indicating low quality of large trees and generally of the whole forest. It is also notable that approximately 22% of total stocking are pole stage (10-20 cm DBH class), the quality of these trees is low exhibited with small and dying crown due to lack growing space. It is believed that most of these poles are of the same age with the large trees but has stagnated due to lack of thinning. The last time the stand was harvested is believed to be 8-12 years before the EnLiFT demo plot is established indicating the inability of previous harvests to encourage regeneration establishment.

Following DBq single tree selection regime, a considerable number of trees from DBH classes 15-40 cm and removal of all trees over 40 cm is suggested. Using the marking guide in Table 2 used by the FUG in selecting and marking residual trees, 30% of the standing tree volume was harvested. Due to the aim of distributing residual trees within the plot and achieving the minimum stocking for 10 mx 20 m marking plot, some trees from over 40 cm DBH was retained. Heavy thinning was also done DBH classes 15 cm – 30 cm to remove dying, diseased, dead and deformed trees. After treatment, Chap seedlings were planted to achieve a total stocking of around 900 tph. A plot demonstrating conversion of the pine plantation to timber forest garden was also established in the Chapani forest guided by ideal DBQ stocking Q-factor 1.3. A Q-factor of 1.3 was chosen for timber fodder forest garden because of the low stocking requirement for large trees and higher stocking in lower diameter classes.

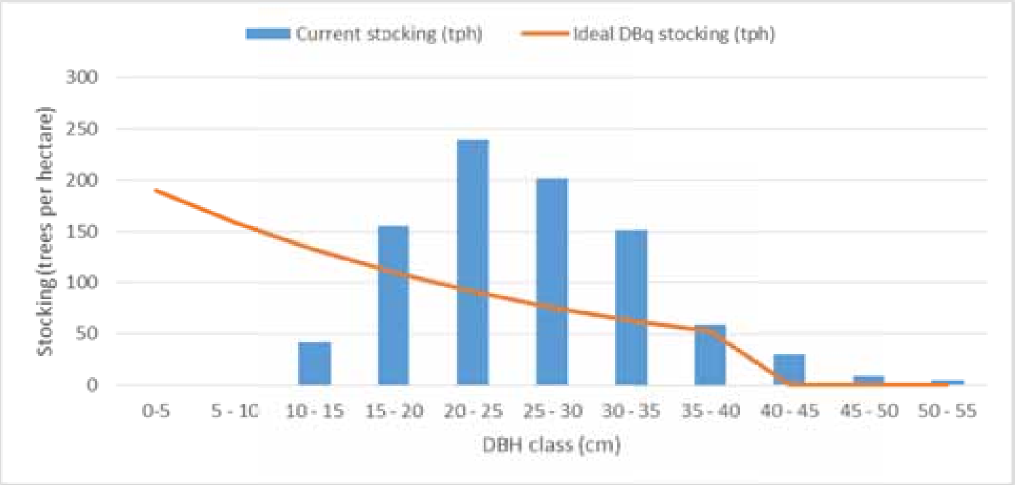

Figure 2. Actual pre-treatment stocking and ideal DBq stocking of Chapani forest (DBq stocking derived for Q-factor=1.2, target basal area = 30 m^2, DBH limit = 40cm).

Table 2. Current stocking, ideal stocking, marking guide, residual stocking and harvest volume before and after DBq single tree selection treatment in Chapani Forest.

DBH class (cm)	Plot tree count*	Current stocking (tph)	Ideal DBq stocking (tph)**	Marking guide***	Plot residual tree count	Residual stocking (tph)	Plot harvested tree volume (m^3)****	Plot residual tree volume (m^3)****
0-5	-[a]	-[a]	190	4	-	-	-	-
5 - 10	0	0	158	3	-	-	-[b]	-[b]
10 - 15	10	24	132	3	1	2	0.86	0.06
15 - 20	37	88	110	2	7	17	4.83	1.15
20 - 25	57	136	91	2	19	45	12.92	6.12
25 - 30	48	114	76	2	20	48	15.91	10.74
30 - 35	36	86	63	1	16	38	16.15	12.72
35 - 40	14	33	53	1	9	21	5.68	11.17
40 - 45	7	17	-	-	5	12	3.11	8.02
45 - 50	2	5	-	-	1	2	2.19	1.95
50 - 55	1	2	-	-		0	1.37	-
Total	212	505	873	18	78	186	63.0	51.9

*Plot area is 4200 m^2

**Ideal stocking = q factor 1.2, DBH limit=40cm, basal area 30m^2.

***Marking guide = number of trees per 10m x 20m, the number of trees was derive by dividing the ideal stocking for each DBH class by 50 and rounded to the next higher number of trees.

****Standing tree volume was calculated following Cedamon *et al.* (2017)

[a]Seedlings were not counted during the pre treatment inventory but generally no seedlings was present

[b]Tree volume for this DBH class was not calculated.

PROCEEDINGS

Example of application of DBq regime for Lampata Sal Forest (Taksar, Lamjung)

Lampata community forest has a total land area of 75 hectare Sal (*Shorea robusta*) with some Katus (*Castanopsis indica*) and Chilaune (*Schima wallaichii*) managed by 246 household of which the effective forest area is estimated to be 55 ha. Like other community forests in Nepal, Lampata forest is managed for timber, fuelwood, grass and leaf litter. Due to high number of forest users, slow growth of timber and full stocking of forest, forest users often encounter shortage of fuelwood and fodder from the forest. Timber is generally provided to user on a priority basis at a forest user's timber price that is 25% of the market price for Sal. Sale of Sal timber to outside the village has not been experienced by the forest users due to conservative annual allowable cut.

The Lampata forest is a natural regeneration that developed by a strict prohibition of open grazing in the forest and current has an uneven age structure showing and inverse J-shape DBH distribution (Figure 3). As argued earlier, this stocking distribution was achieved by adhoc negative tree selection, the forest user group is challenged by the lack of trees that may be available to meet forest users needs for timber. It is also observed that the quality of seedlings and saplings is very low although there is sufficient number on the forest floor. The quality of standing trees is also poor due to lack of information on assessing tree quality. The ideal DBq stocking shown in Figure 3 suggests that trees over 40 cm DBh may be available for harvest representing 6% of the total tree count. As shown in Figure 3, stocking in DBH classes in 15-40 cm are all below or on the ideal DBq line indicating that all trees in these classes should be retained but is not the case due to the need to cut bad and deformed trees in the stand to make sure that regeneration is coming from healthy and vigorous mother trees.

The abundance of poor quality poles and saplings make the single tree selection regime for Lampata forest became challenging. Heavy thinning of sapling (5-10 cm DBH) and poles (10-15 cm) removing deformed and thin trees on dense areas. As shown in Table 3, more than half of the saplings and poles were remove representing 39-45% of the total timber stock. The forest user group also decided to remove deformed and damage large trees to allow better and faster growth of good quality trees on the same size class and in lower size class removing just over half of the standing volume of sawlogs. The selection system implemented in Lampata may be seen as over harvesting but in reality the regime is able to refine the stand by removing badly damage large size Chilaune and Sal trees as well poles and saplings. The treated stand is currently showing abundant healthy regeneration and a faster and better growth of residual saplings and poles. The forest is proud of this system in that it has retained healthy and vigorous residual trees and having a better stand structure compared to irregular shelterwood system applied in a nearby forest. A plot demonstrating conversion of current forest to timber-fodder forest garden was established on Lampata forest using guided by the ideal stocking for Q-factor of 1.2.

The major challenge in implementing DBq-based single tree selection regime in forests like the Lampata forest is the difficulty in achieving the ideal stocking on a per hectare basis. This is due to the fact that most forests have irregular spacing of trees such that some patches are dense and others are sparse. Following the marking guide for a 10 m x 20 m plot (see Tables 2 and 3) it is possible that the residual stocking may be lower than the ideal stocking. However this can be easily corrected in the succeeding cutting operations.

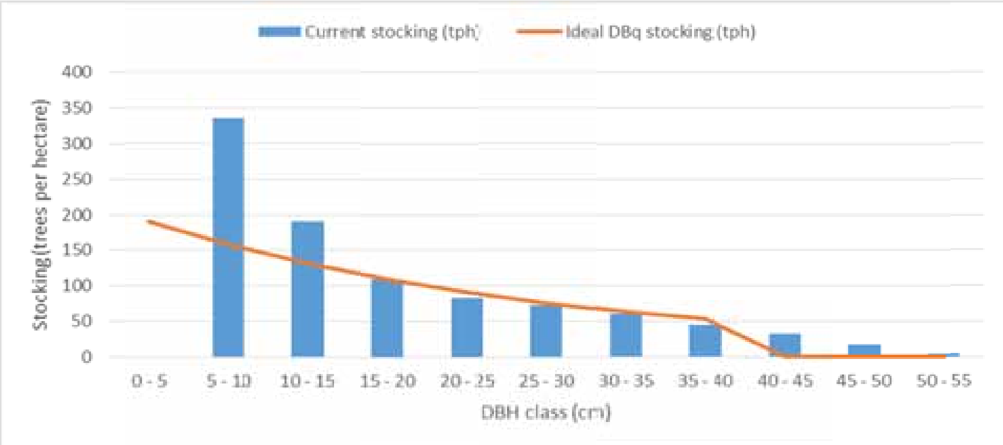

Figure 3. Actual pre-treatment stocking and ideal DBq stocking of Lampata forest (DBq stocking derived for Q-factor=1.2, target basal area = 30 m², DBH limit = 40cm).

Table 3. Current stocking, ideal stocking, marking guide, residual stocking and harvest volume before and after DBq single tree selection treatment in Lampata Forest.

DBH class (cm)	Plot tree count*	Current stocking (tph)	Ideal DBq stocking (tph)**	Marking guide***	Plot residual tree count	Residual stocking (tph)	Plot harvested tree volume (m^3)****	Plot residual tree volume (m^3)****
0 - 5	-a	- a	190	4	-	-	-	-
5 - 10	134	335	158	3	2	5	- b	- b
10 - 15	76	190	132	3	31	78	1.95	2.42
15 - 20	44	110	110	2	27	68	3.20	4.95
20 - 25	33	83	91	2	20	50	3.84	9.08
25 - 30	29	73	76	2	15	38	9.52	10.43
30 - 35	24	60	63	1	10	25	15.42	12.49
35 - 40	18	45	53	1	8	20	15.19	14.62
40 - 45	13	33	-	-	5	13	14.98	11.17
45 - 50	7	18	-	-	3	8	10.42	8.51
50 - 55	2	5	-	-	-	-	6.22	-
Total	173	904.7619	873	18	121	303	80.75	73.68

5. Proposed Guidelines for Selection Silviculture System in Nepal (1000)

Moving on from demo plot to whole forest silviculture intervention, the following steps are proposed as a simple guideline for implementing single tree selection silviculture on community forests in Nepal.

Step 1: Decide on the desired basal area (m^2) of residual stand and largest target diameter class,

Step 2. Decide on a q factor (between 1.1 - 2.0), Step 3. From Table of K values deverived by Cancino and Gadow (2002) provided in Table 1, find the K values for desired q factor and max, say q=1.3, largest DBH =40 cm = 0.684,

Step 4. Using K values, calculate the number of trees (Ni) for the largest diameter class for one hectare stand. For example, if the desired basal area of 30 m^2, then Ni = 30/0.684=43.8596 ≈ 44 trees,

Step 5. Once the derive the actual tree distribution by DBh classes number of trees in the largest diameter class is obtained, calculate for the next lower diameter class, Ni-1= 44*1.3 = 57.2 … and so on. (Calculations for Q-factor 1.2-1.6 for basal area 30 m^2 and 40 m^2 is provided in Appendix 1),

Step 6. From data obtained from a forest inventory either following the Community Forest Inventory Guideline or based on Rapid Silviuclutre Appraisal (see Cedamon *et al.,* 2017). Then, calculate for the number of harvestable stems per DBH class = actual stocking - ideal stocking,

Step 7. Calculate the harvestable volume per hectare (HVH) = average stem volume on the dbh class * number of harvestable stem per DBH class (step 6),

Step 8. Calculate for the harvestable volume for the whole forest (WFV) = HVH * area of the forest = example 200 cu.m./ha* 120 hectares = 200*120=24,000 cu.m.,

Step 8. Calculate for the Felling cycle = WFV/AAC, for example AAC = 600, 24000/600=40 years,

Step 9. Determine the Annual Felling Area = Forest Area/ Felling Cycle Length (years) = 120 ha/40 years = 3 ha/year,

Step 10. For each felling area, derive the ideal residual stocking per hectare and the number of trees per DBH class for 10m x 20m sub plot for marking residual trees. See examples from Lampata and Chapani forests for this procedure. Follow existing guidelines for marking trees and documentations required for obtaining harvesting permit.

6. Concluding Comments

Many community forests in Nepal are managed based on adhoc 'selection system' such removal of dead and dying trees as well as few big trees. There is now an increasing interest to manage community forests based on scientific forestry however examples of practicing scientific forest management and practical guidelines are lacking. This paper tried to present selection silviculture based on diameter distribution, basal area and q-factor (DBq). As shown in the examples for Chapani and Lampata Forests, DBq selection silviculture system is not necessarily difficult if target DBH distribution for residual stocking is provided to forest user groups in guiding harvesting. The authors believed that misunderstanding of how 'proper' selection silviculture works has caused much reluctance by foresters to accept or to apply it. The misunderstanding is exacerbated with confusions between late thinning and selection silviculture which boundaries between the two are often not understood. Another issue with regards to selection silviculture is the difficulty to harvest marked trees over a range of diameter classes without damaging the residual growing stock. To some degree this is true but this is other silviculture systems except clear felling may also pose damage to residual trees. Given that tree felling and skidding on community forests in Nepal is generally manual, tree damaged will always occur and that tree damaged is generally low.

Selection silviculture based on DBq is generally new in community forestry, trainings should be provided to foresters who are could then provide trainings to forest users. Silviculture demonstration plots established by EnLiFT are generally important show cases to assist these trainings. In delivering trainings, it is important that Foresters are refreshed with theories and principles of forest ecology and management to be able to fully grasp uneven age forest management and implementation of silviculture system based on diameter distribution.

The examples from Chapani and Lampata forests provided in this paper are simple guidelines for practicing selection silviculture based on revers J curve. In deriving the residual stocking for DBq selection, the K value is the key parameter for calculating the number of residual trees. These values are provided in Table 1 to allow foresters to calculate stocking not provided in Appendix 1. The implementation of DBq system is assisted with a tree marking guide which provide the number of residual trees in a particular DBH class for 10m x 20m subplot. The size of the marking plot may be decreased or increased depending on the pre-treatment tree density.

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Appendix 1. Ideal stocking table of a 1-hectare forest based on DBq for basal area 30m^2 and 40m^2, DBH limit of 40-50cm and q-factors 1.2 to 1.6

Basal Area of 30 m^2, DBH limit 50 cm

DBH classes (cm)		Q-factor				
		1.2	1.3	1.4	1.5	1.6
0	5	129	204	303	426	570
5	10	107	157	217	284	356
10	15	89	121	155	189	223
15	20	74	93	111	126	139
20	25	62	71	79	84	87
25	30	52	55	56	56	54
30	35	43	42	40	37	34
35	40	36	33	29	25	21
40	45	30	25	21	17	13
45	50	25	19	15	11	8
Total stocking (tph)		647	821	1025	1255	1506

Basal Area of 30 m^2, DBH limit 45 cm

DBH classes (cm)		Q-factor				
		1.2	1.3	1.4	1.5	1.6
0	5	154	234	335	459	602
5	10	128	180	240	306	376
10	15	107	138	171	204	235
15	20	89	106	122	136	147
20	25	74	82	87	91	92
25	30	62	63	62	60	57
30	35	51	48	45	40	36
35	40	43	37	32	27	22
40	45	36	29	23	18	14
Total stocking (tph)		744	918	1119	1343	1585

Basal Area of 30 m^2, DBH limit 40 cm

DBH classes (cm)		Q-factor				
		1.2	1.3	1.4	1.5	1.6
0	5	190	275	381	507	651
5	10	158	212	272	338	407
10	15	132	163	195	225	254
15	20	110	125	139	150	159
20	25	91	96	99	100	99
25	30	76	74	71	67	62
30	35	63	57	51	45	39
35	40	53	44	36	30	24
Total stocking (tph)		873	1048	1246	1463	1697

Basal Area of 40 m^2, DBH limit 50 cm

DBH classes (cm)		Q-factor				
		1.2	1.3	1.4	1.5	1.6
0	5	171	272	404	568	760
5	10	143	209	289	378	475
10	15	119	161	206	252	297
15	20	99	124	147	168	185
20	25	83	95	105	112	116
25	30	69	73	75	75	72
30	35	57	56	54	50	45
35	40	48	43	38	33	28
40	45	40	33	27	22	18
45	50	33	26	20	15	11
Total stocking (tph)		862	1094	1366	1673	2008

Basal Area of 40 m^2, DBH limit 45 cm

DBH classes (cm)		Q-factor				
		1.2	1.3	1.4	1.5	1.6
0	5	205	311	447	612	803
5	10	171	239	319	408	502
10	15	142	184	228	272	314
15	20	118	142	163	181	196
20	25	99	109	116	121	123
25	30	82	84	83	81	77
30	35	69	65	59	54	48
35	40	57	50	42	36	30
40	45	48	38	30	24	19
Total stocking (tph)		992	1223	1491	1790	2112

Basal Area of 40 m^2, DBH limit 40 cm

DBH classes (cm)		Q-factor				
		1.2	1.3	1.4	1.5	1.6
0	5	253	367	509	676	868
5	10	211	282	363	451	543
10	15	176	217	260	300	339
15	20	146	167	185	200	212
20	25	122	128	132	134	132
25	30	102	99	95	89	83
30	35	85	76	68	59	52
35	40	71	58	48	40	32
Total stocking (tph)		1165	1396	1661	1950	2262