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The Link Between the Garhwali People and Their Forests

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This study examines the practice of lopping of Quercus leucotrichophora *A. Camus and* Quercus floribunda *Lindley ex Rehder in Garhwal Himalaya. The study objectives were to investigate the lopping process, the factors that influence it, and the changes it has undergone between 1993 and 2006, specifically, age and gender roles, method of fodder collection, type of branches and trees lopped, and weight of oak foliage bundles. Data were collected for 49 fodder collection trips in Beli village, Tehri Garhwal District, Garhwal Division. Four closely interlinked factors influenced forest use—gender roles, availability of oak foliage in the forest, number and type of livestock per household, and type of agricultural crops planted. The results indicate that lopping practice is not static. It has undergone fundamental changes between 1993 and 2006. Beli villagers continued to collect fodder basis, varied the fodder species collected, and rotated the location of trees lopped throughout the year in 2006, as they did in 1993. Foliage collection intensified until early 2000 when there was a marked decrease in the amount of foliage available in the forest. As a result, the villagers began to reduce their total reliance on the forest and agriculture for income and instead began to send their children to school in preparation for employment outside the village. This change in livelihood strategy is reflected in the lopping practice. Fodder collection trips decreased from 5 in 1993 to 3 times a day in 2006. The number of people collecting* Q. floribunda *decreased from 26 to 12, with fodder being collected mainly by women aged 21 to 26. This has resulted in females carrying significantly greater loads in 2006 (*P = 0.0004*). Examining the lopping practice provides insights into the impact of fodder collection on forest ecosystems and, in turn, the forest's impact on peoples' lives.*

Keywords: *Lopping; forest use; fodder; oaks;* Quercus leucotrichophora*; fodder; gender; indigenous resource use; Garhwal Himalaya; Uttarakhand.*

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Introduction

Lopping of oak trees has been a source of tension between forest managers and villagers in the Central Himalaya of India. The 1927 Forest Act codified the reservation of forests, placed boundaries around the forests, and prohibited the village people from cultivating forested land, lopping trees, or grazing livestock in the forest (Tucker 1984, 1986; Rawat 1989). As early as 1937, R. M. Gorrie of the Forest Research Institute in Dehra Dun claimed that the oaks "were so mutilated by continuous lopping that they are rapidly dying out" (Gorrie 1937). Human disturbance of forest stands and energy flow between forests and agriculture have been analyzed in the Central Himalaya (Babu et al 1984; Pandey and Singh 1984; Singh et al 1984; Datt 1993; Negi and Todaria 1993; Sundriyal and Sharma 1996; Tripathi and Sah 2001; Dove et al 2005). Yet these studies do not systematically examine the key link between humans and the forest—the lopping practice itself (Moench and Bandyopadhyay 1986; Mahat et al 1987; Negi et al 1999).

Fodder fed to livestock consists of fresh green oak foliage, green or dried grass from the forests, green grass from the agricultural fields, and dried wheat or rice stalks (Singh and Naik 1987; Makino 1994; Singh and Bohra 2005). Pandey and Singh (1984) found that up to 87% of the fodder requirement was met by the forest. A consistent supply of fodder is essential for sustaining the agricultural livelihood of the rural communities (Negi 1977; Moench and Bandyopadhyay 1986; Nautiyal et al 1987; Singh and Naik 1987; Moench 1989; Makino 1994; Rathore et al 1995; Negi et al 1997; Reddy and Chakravarty 1999; Sharma et al 2009). Crops require compost, which is made by mixing livestock manure with dry leaf litter from the forest (Pandey and Singh 1984). The villagers prefer compost over commercial fertilizers because the urine also acts as a natural pesticide and it is free (Makino 1994). Therefore, increase in the demand for compost requires an increase in the number of livestock and a greater demand for oak foliage. Lopping, that is, cutting the branch at the attachment to the bole by a sickle, is the method used to collect oak foliage

(Macfarlane 1976; Sharma et al 2009). Thus the lopping practice is the link between the health and persistence of the forest ecosystems and the livelihoods of the village people. Without a detailed understanding of lopping, we can neither resolve the threat to the forest ecosystems nor the threat to the livelihoods of the rural village society.

The study objectives were to systematically examine the lopping practice and the factors that influence it, as well as the changes it underwent from 1993 to 2006. Specifically, I investigated (1) the shifting priorities of households by analyzing the influence of age and gender roles on lopping practices and (2) fodder collection methods including site selection for lopping trees, lopping techniques, tree species lopped, diameter at breast height (Dbh) of trees lopped, diameter of branches lopped, and weight of oak foliage bundles carried out of the forest.

Methods

Study area

Beli village (pseudonym) is located at 30°28′N latitude and 78°11′E longitude, in Garhwal Division, Uttarakhand, India. It is in the temperate montane region of the Central Himalaya, which ranges from 1500 to 3500 m in elevation and is characterized by moist temperate mixed evergreen broadleaf and conifer vegetation. The average monthly rainfall from 1993–2006 was 581.4 mm; most rainfall occurred in July (DFO 2006). The vegetation is dominated by *Quercus leucotrichophora* A. Camus between 1800 and 2400 m and *Quercus floribunda* Rehder between 2000 and 2700 m. The forests surrounding the village are classified as Reserve Forests by the Forest Department of Uttarakhand and are not commercially logged.

The village is divided into 3 settlements patterned after the transhumance lifestyle of the people before the 1800s (Ram 1988; Moench 1989; Berreman 1993). Migration of both people and livestock from one settlement to another occurs according to the cropping seasons. The main village is at an elevation of 1854 m. The lower settlement or *nadi* is located 17 km south of the village in the Aglar river valley at 500 m. This settlement is used only in July during seasons of potato harvesting and rice transplanting. The upper settlement, called *chan* or *danda,* is located 0.7 km above the village at 2110 m. The villagers' main source of income is agricultural production (Director of Census Operations Uttaranchal 2004).

Since the building of a road in 1978 near the village, Beli has access to 3 markets approximately 17 to 30 km away. The paving of the road in 2000 further improved access and increased vehicular traffic to the region. The most significant change that has occurred in the village between 1993 and 2006 is the increase in the number of schools from only 1 government primary school in 1993 to 2 primary schools, 1 girl's boarding school, and 1 high school in 2006.

Methodology

The data were collected from May to August in both 1993 and 2006. Twenty-two fodder collection trips were made in 1993 and 27 trips were made in 2006. The following data were recorded for each fodder collection trip: (1) informal observations on the lopping method; (2) number, gender, and age composition of the fodder collection group; (3) distance and time traveled to collect fodder; (4) location of forest lopped; (5) elevation and aspect of the collection site; (6) Dbh and tree species lopped by name, gender, and age; (7) diameter of each branch lopped per tree by name, gender, age, and species (the diameter of every branch lopped was measured at its attachment to the bole of the tree); and (8) weight of oak foliage bundles by name, gender, and age.

The data were analyzed using Pearson correlation and multiple linear regression analysis. Univariate ANOVA was used to compare the diameter of branches lopped per tree, Dbh of tree, and the number of branches lopped between 1993 and 2006. Type I error rate was set at 0.05.

Results

Fodder collection

Fodder collection is conducted in groups consisting of kin or school friends. The matriarch of the household determines whether oak foliage, grass, fuelwood, or leaf litter needs to be collected that day and who should collect it. The location for collecting fodder is determined by the climatic season, agricultural cropping cycle, the time of day, the settlement from which the fodder collection group departs from, and the age and gender composition of the group.

The method for feeding water buffaloes, cows or bulls, and goats as well as the season determine the fodder type collected from the forest (Table 1). The water buffalo are stall fed all year round, most cows and bulls are grazed during the summer (March–June) and monsoon (June–August) months, and the goats are grazed all year round. The livestock, stall fed during the summer, are fed foliage of *Q. floribunda* and *Q. leucotrichophora*. The number of people collecting fodder decreases in July when the rice-transplanting season begins in the Aglar valley, and many families take their livestock with them. At the end of July they return to the main village settlement and *chan* for the potato harvest season. During the monsoon season, fodder consists of grass from the fields and forest and *Q. leucotrichophora*. In the winter (January–March) the villagers feed grass they collected and dried in October and November along with dried wheat and rice stalks from that year's harvests. *Q. leucotrichophora* foliage close to the village settlements is also collected and fed during the winter.

Oak trees with the greatest amount of foliage are chosen for lopping. Traditionally people leave some

TABLE 1 Comparison of fodder types (*Quercus leucotrichophora* and *Quercus floribunda*) collected and fed to livestock during 4 seasons of the year, 1993 and 2006, in Beli village, Garhwal Division, Uttarakhand, India.

Livestock	Seasons			
	Winter (December–mid-March)	Summer (mid-March–mid-June)	Monsoon (mid-June–August)	Fall (September–November)
Water buffalo	Dried grass Dried wheat/rice stalk *Q. leucotrichophora*	*Q. leucotrichophora* *Q. floribunda*	*Q. leucotrichophora* Grass	*Q. leucotrichophora*
Cow/ bull	Dried grass Dried wheat/rice stalk *Q. leucotrichophora*	Graze	Graze	Graze
Goat	Graze	Graze	Graze	Graze

foliage at the top of the tree based on a belief that leaving it will prevent the tree from dying (Figure 1). Foliage is removed from the larger branches and gathered into bundles, and the larger branches are discarded and collected the following year for fuelwood. Foliage is tied together using the fibrous bark of *Wikstroemia carescens* Meissn. or *Viburnum cotinifolium* D. Don. Females carry the foliage bundles on their heads, and males pierce them with a stick or *sweti* and carry them on their backs. People share foliage with others of the group if they have lopped more than they can carry.

Five things stayed the same in the interaction between the people and the forest from 1993 and 2006. The people still depended on the forest for oak foliage as fodder and made daily trips into the forest. The Reserve Forests surrounding the village used for fodder in 1993 were the

FIGURE 1 Comparison of a *Quercus leucotrichophora* tree (A) before and (B) after lopping. The lower branches have been lopped and the top has been left. Lopped forest near Beli village, Garhwal Division, Uttarakhand, India. (Photos by the author)

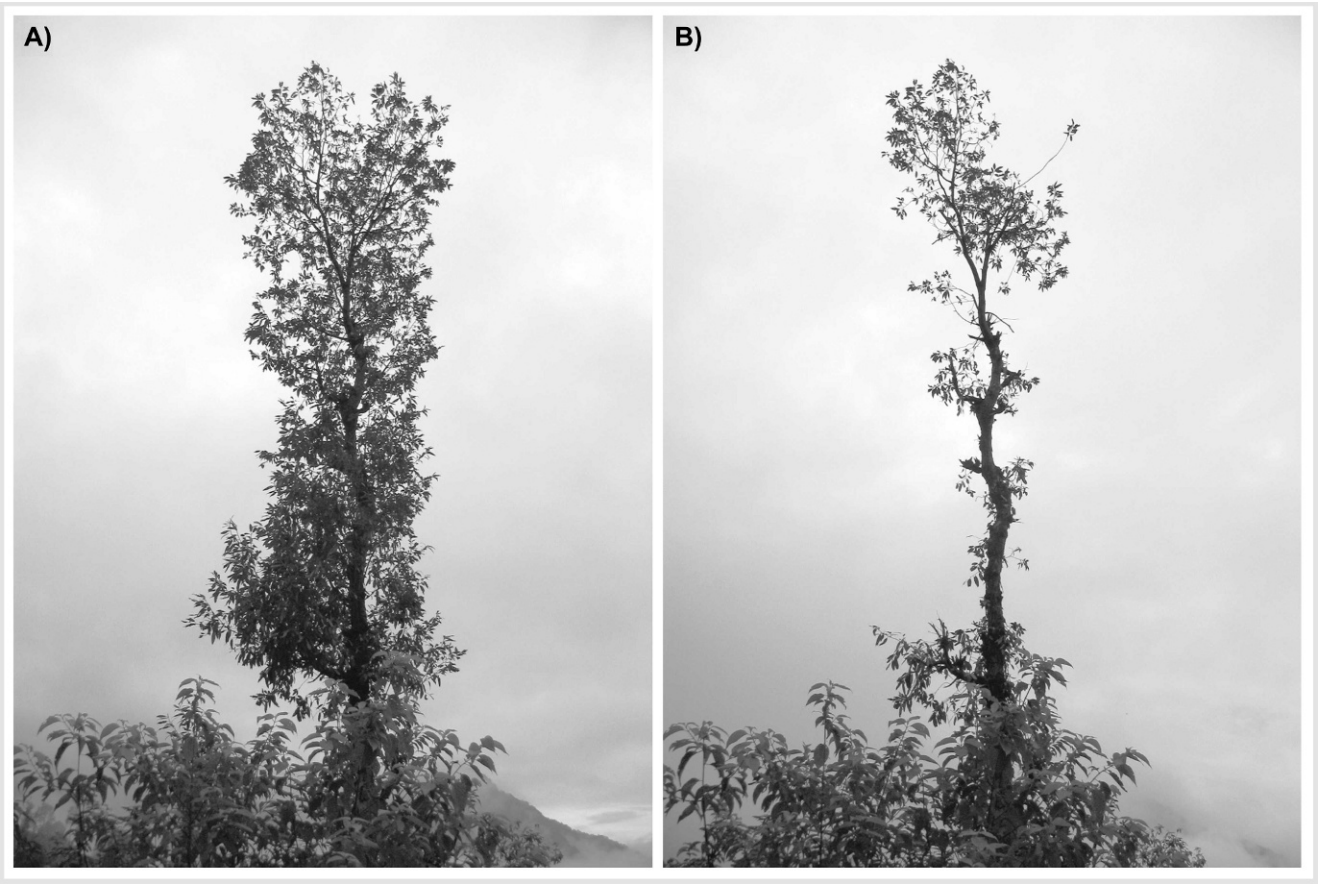

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TABLE 2 Comparison of fodder (*Quercus leucotrichophora* and *Quercus floribunda*) collected in 1993 and 2006 during the summer (mid-March to mid-June) and monsoon (mid-June to August) months in Beli village, Garhwal Division, Uttarakhand, India.

Settlement	Year	
	1993	2006
Beli village	7:30 AM–1:00 PM *Q. floribunda* 3:00–8:00 PM *Q. leucotrichophora*	8:00–11:00 AM *Q. leucotrichophora*
Chan	7:00–9:00 AM *Q. leucotrichophora* 7:30 AM–1:00 PM *Q. floribunda* 2:00–6:00 PM *Q. leucotrichophora*	8:00 AM–1:30 PM *Q. floribunda* 2:00–6:00 PM *Q. leucotrichophora*

same as those in 2006. The people continued to use a sickle to cut the branches off trees and remove the smaller twigs with foliage. Both *Q. leucotrichophora* and *Q. floribunda* continued to be collected for fodder and rotated according to the annual seasons (Table 2). However, the 2 differences in 2006 were the decrease in the number of fodder collection trips into the forest and the number of people collecting fodder.

Q. floribunda is collected in May and June (Table 1). Since *Q. floribunda* is a higher elevation species, the villagers take only 1 trip a day and walk for 6 to 7 hours (Figure 2). In 1993 a group from the village and another group from the *chan* went to collect *Q. floribunda* in the morning. *Q. floribunda* collection groups were large and consisted of 12 to 32 people (Table 3). The composition of the groups ranged from 4 to 14 females and 4 to 12 males. The ages of females collecting fodder ranged from 12 to 50 and the ages of males ranged from 8 to 20.

In 2006 only 1 group from the *chan* went to collect *Q. floribunda* in the morning (Table 2; Figure 2). No group left from the village. The fodder collected alternated between *Q. floribunda* on one day and grass the next. The

FIGURE 2 Map showing the relative location of fodder collection sites in 2006 according to oak species or grass collected around Beli village, Garhwal Division, Uttarakhand, India. (Map by the author)

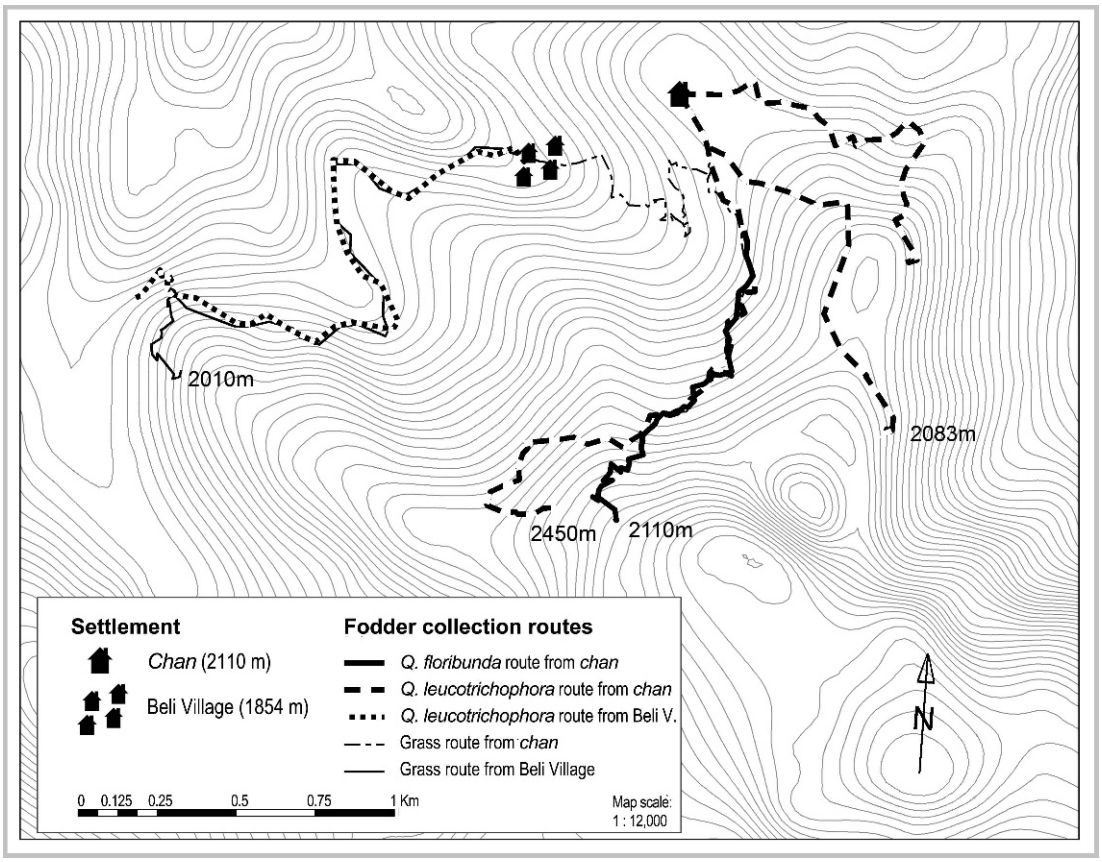

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TABLE 3 Comparison of the ages and numbers of females and males in fodder (*Quercus leucotrichophora* and *Quercus floribunda*) collection groups from the main Beli village and *chan* in 1993 and 2006.

Type of fodder collection group and settlement		1993		2006	
		Females	Males	Females	Males
Q. floribunda (*chan* and Beli village)	Number of people	4–14	4–12	2–8	1–4
	Age (years)	12–50	8–20	12–53	15–25
Q. leucotrichophora (Beli village)	Number of people	3–8	1–4	1–2	1–2
	Age (years)	13–17	8–12	21–26	12–18
Q. leucotrichophora morning fodder collection group (*chan*)	Number of people	3–4	0	NA	NA
	Age (years)	13–50	NA	NA	NA
Q. leucotrichophora afternoon fodder collection group (*chan*)	Number of people	1–2	3–5	1–8	1–6
	Age (years)	40–50	13–15	11–16	11–16

location was decided by consensus. Groups traveled from 1 to 2.8 km to reach the *Q. floribunda* site, located at around 2450 m in elevation. The number of people in a group ranged from 1 to 10, considerably less than 1993. The number of females in a group ranged from 1 to 8 and 1 to 4 males. The ages of females collecting fodder ranged from 12 to 53, and the ages of males ranged from 15 to 25.

In 1993 *Q. leucotrichophora* collection trips left from both the village and the *chan* except during July and August when *Q. leucotrichophora* was collected only in the afternoon in the village (Table 2). The lopping sites were approximately 2 km from Beli village. The groups consisted of approximately 4 to 8 people and were considerably smaller in size than the *Q. floribunda* collection groups (Table 3). The groups were composed mainly of females between the ages of 13 and 17 and males between the ages of 8 and 12.

There was a marked difference in 2006 compared to 1993 in the number of trips, group composition, and the number of people in the *Q. leucotrichophora* fodder collection groups (Table 3). Fodder collection from the main village was done in the mornings by single individuals, rather than by groups. The females were aged 21 to 26 and consisted mainly of daughters-in-law while the mothers-in-law worked in the fields. The males were those aged 12 to 18 and did not attend school. However, the fodder collection sites were the same as in 1993 and were at elevations of 1854–2010 m at about 0.2–2.5 km from the village (Figure 2).

In contrast to 1993 when 2 trips a day were made from the *chan* to collect *Q. leucotrichophora*, only 1 trip was made in 2006. The groups consisted of children who attended school in the morning. The fodder collection sites were located between 0.74–2.3 km from the *chan* at an elevation of 2083 m (Figure 2). The ages of both the females and males ranged from 11 to 16, and a group consisted of 2 to 9 people (Table 3).

Comparison of lopping practices between gender and ages

Diameter at breast height (Dbh) of trees lopped: In 1993 and 2006, the average Dbh of trees lopped by females was 21.9 and 20.6 cm, respectively; for males it was 27.4 and 27.8 cm, respectively (Table 4). There was no significant difference between the Dbh of trees lopped between 1993 and 2006 by females, with an average age of 20.3 (P = 0.61). There was no significant difference between the Dbh of trees lopped between 1993 and 2006 by males with an average age of 14.9 (P = 0.31). For both 1993 and 2006, the body weight of males and their age were good predictors of the Dbh of trees they lopped. For females the body weight and age were not significant predictors.

Number of branches lopped per tree: In 1993 and 2006, the average number of branches lopped by females was 44 and 63, respectively, and for males 58 and 75, respectively (Table 4). For females, there was no significant difference in the number of branches lopped between 1993 and 2006 (P = 0.13), and the age averaged 20.3. For males, there was no significant difference in the number of branches lopped between 1993 and 2006 either (P = 0.19), with an average age of 14.3. For the 2006 data, age was a good predictor of the average number of branches lopped per tree for females (P = 0.01) but not for males (P = 0.48).

Diameter of branches lopped: In 1993, the average diameter of branches lopped by females was 1.6 cm (Table 5). The variation in the diameter of branches lopped was greater in females below age 20 (Figure 3). However, as they grew older, there was a slight negative but not significant trend in diameter beginning around the age of 25, and the variation in the diameter of branches became smaller. In 2006 the diameter of the branches lopped by females was 0.99 cm. There was a slight but not significant increase in the diameter of branches lopped with age (P = 0.08) (Table 4). There was a significant difference between the years at the average age of 20.03 (P = 0.0003). The

TABLE 4 Gender specific regression equations for prediction of diameter of branches lopped (cm), number of branches lopped, diameter at breast height (Dbh) of trees lopped (cm), and weight of oak foliage bundles (kg) in 1993 and 2006. The equations are significant at $\alpha = 0.05$.

Year	Variable	Gender			
		Female			
		Regression equation	*P* value	R^2	*F*
1993	Dbh of tree lopped	25.79 − 0.25 * Age	0.19	0.11	$F(1,15) = 1.87$
	Number of branches lopped	$-63.36 + 10.45$ * Age − 0.22 * Age^2	0.53	0.10	$F(2,12) = 0.66$
	Diameter of branches lopped	2.02 − 0.02 * Age	0.16	0.13	$F(1,15) = 2.17$
	Weight of fodder bundle	$-11.7 + 2.83$ * Age − 0.04 * Age^2	0.00	0.67	$F(2,19) = 19.22$
2006	Dbh of tree lopped	17.98 + 0.20 * Age	0.42	0.03	$F(1,20) = 0.68$
	Dbh of tree lopped	16.14 + 0.14 * Body weight	0.60	0.02	$F(1,18) = 0.29$
	Number of branches lopped	−9.65 + 3.64 * Age	0.01	0.30	$F(1,19) = 8.25$
	Diameter of branches lopped	0.68 + 0.02 * Age	0.08	0.16	$F(1,19) = 3.90$
	Weight of fodder bundle	$-0.89 + 2.24$ * Age − 0.03 * Age^2	0.00	0.65	$F(2,31) = 29.35$

TABLE 4 Extended.

Year	Variable	Gender			
		Male			
		Regression equation	*P* value	R^2	*F*
1993	Dbh of tree lopped	10.06 + 1.04 * Age	0.02	0.42	$F(1,10) = 7.32$
	Number of branches lopped	205.29 − 25.39 * Age + 1.01 * Age^2	0.30	0.29	$F(2,7) = 1.44$
	Diameter of branches lopped	−0.66 + 0.17 * Age	0.02	0.40	$F(1,11) = 7.44$
	Weight of fodder bundle	$-32.14 + 5.42$ * Age − 0.09 * Age^2	0.00	0.83	$F(2,15) = 36.54$
2006	Dbh of tree lopped	−0.19 + 1.95 * Age	0.00	0.60	$F(1,15) = 22.06$
	Dbh of tree lopped	7.44 + 0.59 * Body weight	0.01	0.39	$F(1,15) = 9.61$
	Number of branches lopped	−46.18 + 9.51 * Age	0.05	0.24	$F(1,15) = 4.63$
	Diameter of branches lopped	0.18 + 0.05 * Age	0.01	0.36	$F(1,15) = 8.52$
	Weight of fodder bundle	$-60.50 + 7.34$ * Age − 0.122 * Age^2	0.00	0.77	$F(2,21) = 34.79$

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TABLE 5 Comparison of the means and ranges of the diameter at breast height (Dbh) of trees chosen for lopping (cm), number of branches lopped, diameter of branches lopped (cm), and the weight of fodder bundles (kg) carried out of the forest differentiated by gender for 1993 and 2006. Standard deviation is given in parentheses.

Variables	1993		2006	
	Females	Males	Females	Males
Dbh of trees lopped (cm)	Mean: 21.9 (1.55) Range: 9.6–37.2	Mean: 27.4 (1.93) Range: 12.8–42.1	Mean: 20.6 (1.48) Range: 10.5–40.5	Mean: 27.8 (2.08) Range: 19.1–56.0
Number of branches lopped	Mean: 44 (9.27) Range: 4–137	Mean: 58 (7.77) Range: 21–99	Mean: 63 (9.0) Range: 3–185	Mean: 75 (16.21) Range: 13–269
Diameter of branches lopped (cm)	Mean: 1.6 (0.14) Range: 0.2–5.5	Mean: 1.75 (0.30) Range: 0.2–10.5	Mean: 0.99 (0.06) Range: 0.05–11.80	Mean: 0.89 (0.07) Range: 0.10–11.30
Weight of fodder bundle (kg)	Mean: 29.3 (1.75) Range: 18.0–36.5	Mean: 28.6 (3.17) Range: 7.5–54.0	Mean: 29.5 (2.04) Range: 5.0–44.0	Mean: 22.2 (3.41) Range: 6.0–62.0

diameter of branches lopped by females in 1993 was significantly greater than 2006 at the ages below 25. But the difference between the ages became insignificant after age 30.

In 1993, the average diameter of branches lopped by males was 1.75 cm (Table 5). There was a significant (P = 0.02) increasing trend in the diameter of branches lopped as the age increased (Figure 3). The regression equation used to estimate the diameter of branches lopped overestimates for ages 22 and above because of the lack of data. In 2006, the average diameter of branches lopped by males was 0.89 cm. There is a slight but significant increase in the diameter of branches lopped with increase in age (P = 0.01). Again, the regression equation used to estimate the diameter of branches lopped overestimates for ages over 25 because of limited data. There was a significant difference in the diameter of branches lopped between the years 1993 and 2006, with an average age of 14.9 (P = 0.00008) among loppers. The diameter of branches lopped by males in 1993 was significantly greater than those lopped in 2006. The difference tends to increase as the age increases (Table 4).

Weight of the bundles carried out of the forests: In 1993 and 2006, the average weight of bundles carried out of the forest by females was 29.3 and 29.5 kg, respectively (Table 5). The weight of bundles carried by females gradually increased until age 25, and thereafter the weight of the bundles gradually decreased (Figure 4). In 1993 and 2006, the average weight of bundles carried by males was 28.6 and 22.2 kg, respectively. The male data have a more linear relationship compared to the females until the age of 30.

In comparing the weight of bundles carried out of the forest in 1993 with 2006, the univariate analysis of variance test showed that there is a significant year effect for both males and females at their respective average age. For the females, the average bundle weight carried in 1993 at the average age of 24.2 years old was 28.17 kg, whereas in 2006 females carried an average of 31.57 kg. The bundle weight carried by females in 2006 was significantly greater than in 1993 at P = 0.02, differing by 3.4 kg. However, for males, the average bundle weight carried in 1993 at the average age of 15.6 years old was 29.97 kg, which is significantly more than the 21.87 kg carried in 2006 (P = 0.0004). The trend of females carrying heavier bundles than males in 2006 and 1993 is consistent from a young age onward (Figure 4). The bundle weight carried by males in 2006 is significantly less for all the ages. Since there is no interaction between the curves, the tendency for the 2 years is the same.

FIGURE 3 Comparison of the average diameter of oak tree branches lopped in 1993 and 2006 by (A) females and (B) males in Beli village, Garhwal Division, Uttarakhand, India.

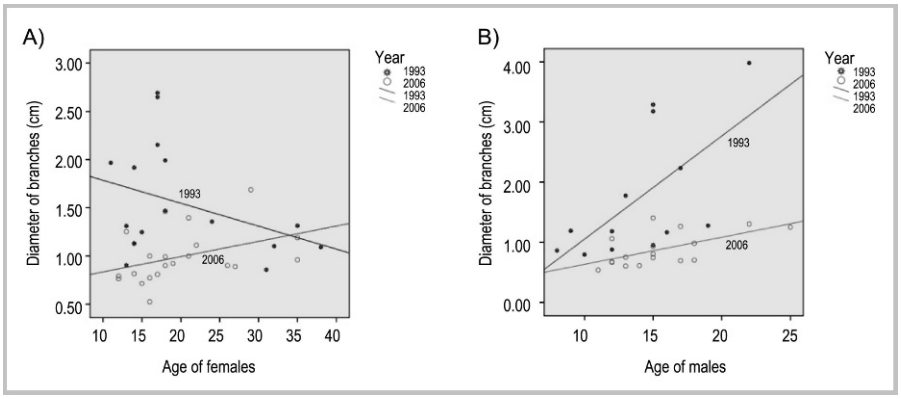

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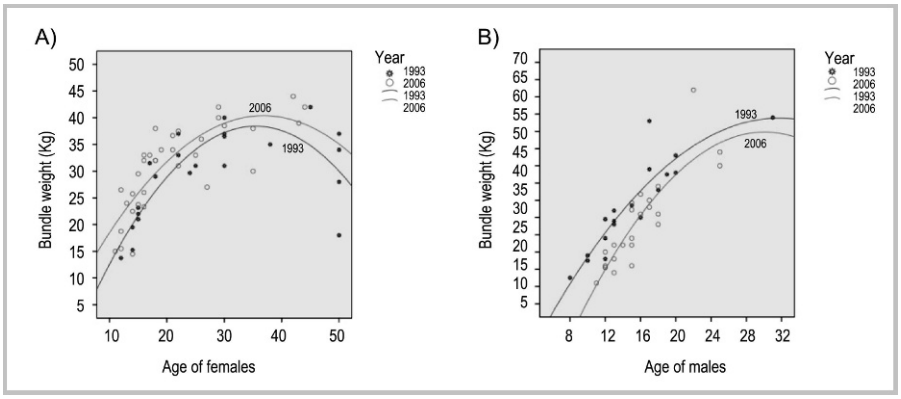
FIGURE 4 Comparison of the fodder bundle weights in 1993 and 2006 by (A) females and (B) males in Beli village, Garhwal Division, Uttarakhand, India.



Discussion

Factors affecting lopping

Lopping practice changed markedly in 13 years demonstrating that rural society is not static; it responds and adapts to resource availability. Sharma et al (2009) found a positive correlation that increasing income led to greater fodder consumption from the forest. However, this study demonstrates that the positive correlation will continue only until fodder use begins to exceed its availability. As fodder becomes scarce, the villagers begin to explore sources of income other than agriculture. The data, segregated by gender and age, also allowed a detailed analysis of the changing lopping practices concomitant with gender and age changes in the village society.

The roots of the transformation in Tehri Garhwal District began in 1978 when the road connecting the village to nearby towns was constructed (Moench 1989). Before 1978, the agricultural produce in Beli village was wheat, rice, and potatoes, which could be transported easily by mules. With the introduction of trucks the agricultural production changed to cash crops such as radish, cabbage, capsicum, and cauliflower. However, vegetables demand more compost, increasing the need for more livestock and fodder. A dramatic increase in the number of livestock has also been observed in other villages in Uttarakhand (Singh and Tulachan 2002). According to the villagers, the increase in livestock continued until the early 2000s when they noticed a marked decrease in foliage availability. This perception by the villagers is also supported by Singh and Bohra (2005), who reported a 19% deficit in green fodder in the midaltitude Himalayan hills in 2001. The decrease in foliage availability, led to a decrease in the number of fodder collection trips and ultimately a lesser amount of fodder gathered in 2006 compared to 1993.

The shift from agriculture as the main source of income to other forms of employment increased the need for literacy. Therefore, in 2006, most of the children were being sent to school in comparison to 1993. The literacy rate of males from 1981 to 2001 increased from 30 to 71%; for females the increase was from 0 to 19% (Director of Census Operations 1981; Vijayan Unni 1999; Director of Census Operations Uttaranchal 2004). Therefore, in 2006, the fodder collection groups were composed of people no longer attending school. With more children being sent to school, there were fewer people available for fodder collection. This meant that the females needed to carry more fodder, as reflected in the increased weight of their bundles in 2006.

Lopping

Understanding the relationship between age and gender and the diameter of branches lopped determines how quickly the tree will assume the "poodle-like" appearance of lopped trees and the impact a particular fodder collection group has on the forest. The positive correlation between the thickness of the branches lopped and age is most likely due to the increase in body weight and strength as the collector grows older. As body weight increases, it is increasingly difficult and dangerous to climb farther out on a branch or higher in a tree. Therefore, the stronger individuals tend to lop the entire branch and then remove the smaller twigs. Likewise, the young females tend to have greater variation in the diameter of branches that they lop because of their greater variation in their size and body weight. However, the variance disappears in the females above 30 years of age because they tend to be smaller in size and because they prefer to lop smaller branches which are easier to bundle.

There was no significant difference in the diameter of trees that were lopped in 1993 and 2006; this indicates that the forest density and growth have largely stayed the same over the 13 years. Therefore, the significant difference in the diameter of branches that were lopped by both females and males may signify that the villagers were lopping more epicormic sprouts in 2006 in comparison to 1993, that is, sprouts issuing from the bole of a tree due to physiological stress from an ever smaller and less vigorous crown. This trend also supports the villagers' perception that the forest is providing progressively less foliage.

The relationship between age, gender, and the weight of fodder bundles gives insights into the fodder demand of

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each household. The person or the number of persons sent out from the household is directly related to the number of livestock that are stall fed. Therefore, by observing the age and gender composition of fodder collection groups, one can estimate the amount of fodder collected from the forest.

The relationship between age and fodder bundle weight appears to be similar for both females and males (Figure 4). The initial part of a curvilinear trend of bundle weights is expected because, as age increases, the weight a person can carry also increases as a function of strength. Then, after a certain age, one begins to carry lighter loads. The regression equation tends to overestimate the fodder bundle weights for males over the age of 25 years, due to limited data for males after that age because most males stop collecting fodder at the age of 20 when they usually marry. After marriage, the wife takes over the responsibility of collecting fodder. However, if the male comes from a small joint family or owns a large amount of livestock, he may continue to collect after marriage. Yet, again, he will stop fodder collection once his first child reaches the age of 10 and is able to go collecting.

The foliage bundle weight of males decreased significantly, whereas the bundle weight of females increased from 1993 to 2006. This change is a reflection of the social trend where the females have had to take the responsibility of collecting more fodder due to the decrease in available labor as the children are sent to school. The decrease in available labor has forced a decrease in the number of livestock a household can own, thereby decreasing the amount of compost available to apply on the fields. As a result, the people have become increasingly reliant on chemical fertilizers and pesticides, which must be purchased. Accordingly, more people need to leave the village to seek employment, which again decreases labor available for fodder collection.

Therefore, when studying forest use, it is essential to study the role of females in fodder collection since they are the decision makers and the principle collectors of fodder. However, most studies on forest use and perceptions of the forest have only interviewed heads of the household who were mostly male or the oldest member of the household, who may no longer have been collecting fodder (Mahat et al 1987; Negi et al 1999).

Conclusions

The practice of lopping has undergone fundamental changes between 1993 and 2006. The Beli villagers continued to collect fodder daily, varied the fodder species collected, and rotated the location of trees lopped throughout the year in 2006, as they did in 1993. The changes began when the villagers noticed a decrease in oak foliage available to them and realized that they could no longer rely solely on the forest and agriculture for their livelihood. In order to adapt to the decrease in foliage, the villagers' strategy was to educate their children in preparation for future employment outside the village. This strategy resulted in changing the lopping practice. The age and gender composition of fodder groups changed, the number of fodder collection trips changed, and ultimately, the number and type of livestock that each household owned changed. These changes were reflected in the type of branches that were lopped and the weight of the foliage bundles carried by individuals. Therefore, examination of the lopping practice provides insight into both the current and future health of the forest ecosystems, as well as into the influence of forest health on the lives of the villagers. An in-depth follow-up study on socioeconomic aspects examining the changes over time juxtaposed with the findings of this study would be beneficial to further substantiate the findings of this study.

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