An analysis of farmers' decision-making processes regarding fodder management strategies

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Abstract

The collaborative project 'Strategies for improved fodder production in the dry season in the mid-hills of Nepal using participatory research techniques' amassed data on current fodder management practices in five sites through farmer interviews. Analysis of the data highlighted variations in management practices between farmers and between sites. These variations were discussed within site-specific farmer groups and between group representatives at a series of workshops. The discussions yielded more information on the decision-making processes that farmers employ to determine the quantity and composition of feed offered to livestock at particular times of the year. Among the influences to decisions were constraints to grazing and knowledge of appropriate lopping regimes for different fodder tree species. Varying degrees of access to off-farm fodder sources and the numbers of livestock kept by different households were also seen to affect fodder management decisions. Development activities aimed at reducing labour as a constraint to fodder collection and the exchange of local knowledge regarding local fodder tree management are most likely to result in improvements in the levels of fodder supply for the majority of households in the short term.

1. Introduction

The project 'Strategies for improved fodder production in the dry season in the mid-hills of Nepal, using participatory research techniques' has concentrated over the last three years on collecting information from farmers about fodder management feeding strategies in five villages in the mid-hills. Ten farmers in each village were selected by their respective communities for participation in the project according to indicators of wealth, also defined by the farmers themselves. Thus the selected farmers in each village were ranked by the type and quantity of their land and livestock holdings. The five villages were also selected for their differences in terms of altitude, access to local markets and off-farm feed sources and ethnic make-up *(Kiff, Hendy, Neupane, Basukala, Jan '98)*. These differences, between farmers and between villages, allow an examination of the factors affecting farmers' decision making with regard to fodder management strategies.

This paper outlines only some of the factors which influence farmers' livestock feeding strategies and their relative importance among different farmers and communities involved in the project, as evidenced by information collected in field surveys conducted as part of the project. These factors include local knowledge of fodder species, size of household livestock holdings, labour availability and access to off-farm fodder sources.

2. Methodology

The research findings of this project stem from a series of bi-monthly surveys conducted in the five project villages between March 1998 and May 1999. The surveys consisted of structured questionnaires for interviews with each of the fifty farmers to ascertain the types of fodder collected in each season, how it is shared between livestock types, seasonal dairy output and production objectives *(Kiff, Hendy, Neupane, Basukala, Jan '98)*. The questionnaire was revised after the first two surveys to clarify questions regarding fodder deficits, livestock numbers and meat production. Some data collected from the third survey onwards is therefore missing from (or incompatible with data in) the first two surveys. Each bi-monthly visit included a meeting with the whole farmer group in each village to clarify anomalies or inconsistencies in data from the previous survey.

After preliminary analysis of the data collected over a whole calendar year, workshops were held in each project site to present and discuss findings with the farmer research group and other villagers and local organisations from the area. This was followed by a workshop in Kathmandu at which representatives from all research sites were present and the differences and similarities between results from the five areas could be compared and explained in greater detail *(Vickers, Chhetri, Basukala, Kiff, Amatya, Regmi, May '00)*. It was at these workshops that the interactions of the various factors involved in farmers' fodder management decisions were highlighted. Some of the more significant factors are discussed separately below.

3. Results

3.1 **Size of livestock and land holdings**

Size of livestock holdings and landholdings were the two major factors selected by farmers in the project orientation workshops for group selection to determine wealth ranking within their communities. Livestock holdings fluctuated over the period of the survey in many households but generally remained a reliable indicator of relative wealth. Landholdings remained relatively unchanged for the project period.

As might be expected, fodder collection increased significantly with livestock holdings ($p<0.001$ for the total overall fodders) as illustrated in Table 1. Much of this increase was due to markedly greater grazing fodder collection in households with larger livestock holdings. Despite this increase, fodder collection per livestock unit (including grazing) was lower with higher livestock holdings ($p<0.001$). Households appeared to be unable to collect sufficient fodder for the largest livestock holdings.

Table 1 Associations of livestock holdings and the collection of fodders

Livestock unit holding	**Total fodder collected** (kg DM/day)	**Total fodder per LU** (kg DM/day)	**Grazing fodder** (% total)	**Fodder deficit per LU** (kg DM/day)
	xxx	xxx	ns	x
0.1-2.5	23.4	11.8	10	7.1
2.51-5.0	34.2	9.1	15	5.2
5.01-7.5	44.9	6.9	20	3.7
> 7.5	51.5	5.7	20	2.7

1. Means estimated in GLM AoV models
   x, xx and xxx = F ratio for effect of livestock holding size in AoV significant at $p<0.05$, $p<0.01$ and $p<0.001$ respectively: ns = not significant

Fodder collection was less clearly associated with land holdings. Neither the collection of crop residues or of tree fodders was significantly related to land holdings (as might have been expected if the production of crop residues and access to on-farm trees increased with land holdings). It appears that households were able to compensate for these factors by collecting or purchasing off-farm fodders (see section 3.4).

The general relationship between livestock holding size and fodder per livestock unit is valid across all five villages. However, it cannot be considered in isolation of other factors. Although there is a general trend for land and livestock holdings to increase together with household size, the conditions of individual households with regard to these three variables can vary greatly and the interplay of these factors can result in deviations from the relationship described in Table 1. For example, the two households in Gajuri Chhap with the highest livestock holdings also had the highest landholdings in the village. In January, these two households were collecting more fodder per livestock unit than all other households. In May the major diversions from the relationship between

livestock holdings and fodder per livestock unit were seen in two of the resource poor households whose small livestock holdings had been steadily increasing throughout the year. One of the resource rich households deviated from the relationship in every season except March and July. Thanks mainly to a large pool of labour within this household, they were able to collect as much fodder per livestock unit as farmers with much lower livestock holdings.

Overall, the data indicated that households with larger livestock holdings tend to spread their fodder resources more thinly between animals than those with smaller holdings. The decision to keep more livestock is not primarily based on the ability to maintain the necessary volume of fodder supply. Resource rich households therefore often experience deficits more severe (in terms of shortfall per LU) than poorer households. However, exemptions to this general rule occur at both ends of the scale. Households with small livestock holdings and correspondingly small landholdings and on-farm resources may still be most vulnerable to fodder shortages in the late dry season, despite their low fodder requirements. Conversely, the very richest households in the survey are able to maintain a fairly constant level of fodder supply per livestock unit which, while less than poorer households in seasons of low deficit, is relatively high towards the end of the dry season.

3.2 **Labour availability**

In general, larger households collected more of each type of fodder than smaller households, though these associations were only significant for grazing and total fodders collected ($p<0.001$, as shown in Table 2). The practice of grazing was more common amongst larger households ($p<0.01$); 76% of the largest households (over 9 members) grazed some livestock compared to only 43% of the smallest households (<4 members). Larger households also appeared able to collect more total fodder per livestock unit ($p=0.08$) and were the only households able to increase their fodder collection if they also had larger livestock holdings (interaction significant at $p<0.01$).

Table 2 Effect of household size on the collection of fodders

Household size	**Total fodder collected** (kg DM/day)	**Total fodder per LU** (kg DM/day)	**Grazing fodder** (% total)	**Fodder deficit per LU** (kg DM/day)
	xxx	p=0.08	xx	x
1-3	33.9	7.2	13	4.8
4-6	32.9	7.9	12	2.8
7-9	41.4	8.6	19	5.5
>9	49.6	9.2	23	5.2

1. Means estimated in GLM AoV models;
   x, xx and xxx = F ratio for effect of household size in AoV significant at $p<0.05$, $p<0.01$ and $p<0.001$ respectively: ns = not significant

Household surveys provided additional information on the labour constraints perceived by households for grazing and fodder collection (households reported whether there were labour constraints for these activities in each season). Higher proportions of households reported constraints for grazing and collection of fodder off-farm (0.43 and 0.41) than for collection of fodder on-farm (0.36). Constraints were particularly noted in the May to July survey periods (seasonal effect $p<0.001$), coinciding with labour peaks of dry season feed collection and cropland preparation, and were more seasonally marked in Gauthale and Gajuri Chhap (with the highest livestock and land holdings respectively), as shown in Figure 3. Constraints were more commonly reported for households with larger land holdings ($p<0.01$) but not with larger livestock holdings. However, significant interactions suggested that smaller households reported constraints if they also had larger land holdings ($p<0.01$). Similarly households with higher livestock holdings only reported increased constraints if they also had higher land holdings.

Households grazing some of their livestock tended to be larger in size, have larger livestock holdings and smaller land holdings. The practice of grazing had a significant impact on the overall collection of fodders (as shown in Table 3), probably due mainly to the larger livestock holdings of grazing households. Fodder collection per livestock unit was similar in grazing and non-grazing households. Concentrate utilisation was, however, significantly greater in non-grazing households.

Table 3 The effect of grazing on the collection of fodders and concentrate feeds

	Total fodder	**Grazing fodder**	**Total fodder/LU**	**Fodder deficit/LU**	**Concentrate per LU**
			kg DM/day		
	x	xxx	ns	ns	xxx
Without grazing	30	0	7.4	5.0	0.91
With grazing	41	12	8.3	4.9	0.53

1. Means estimated in GLM AoV models
x, xx and xxx = F ratio for effect of grazing size in AoV significant at $p<0.05$, $p<0.01$ and $p<0.001$ respectively; ns = not significant

Out of the five survey villages only households in Gauthale, Tawari and Gajuri Chhap grazed their livestock regularly throughout the year. Scatter graphs were constructed for these three villages of total households members against average grazing hours per day over the whole year. In Gauthale and, more significantly, in Gajuri Chhap, there was a clear correlation between these two factors (see Fig 1).

In Gajuri Chhap, the household with highest labour availability was also the one which consistently deviated from the relationship between livestock numbers and average fodder per LU described in the previous section. The availability of labour to keep livestock grazing all year round helps to explain this. In this particular household, neither labour nor livestock numbers are significant limiting factors in the supply of fodder throughout the year. However, households with smaller families exhibit different grazing practices. In Gajuri Chhap, those with less than six members do not graze at all in September. In this season, the late monsoon, labour is in demand for agricultural work.

The larger households are more consistent in their grazing practice over all seasons. The data suggests that, in areas where grazing is a common practice, household size and thus labour availability, is an important factor in determining whether and when to graze.

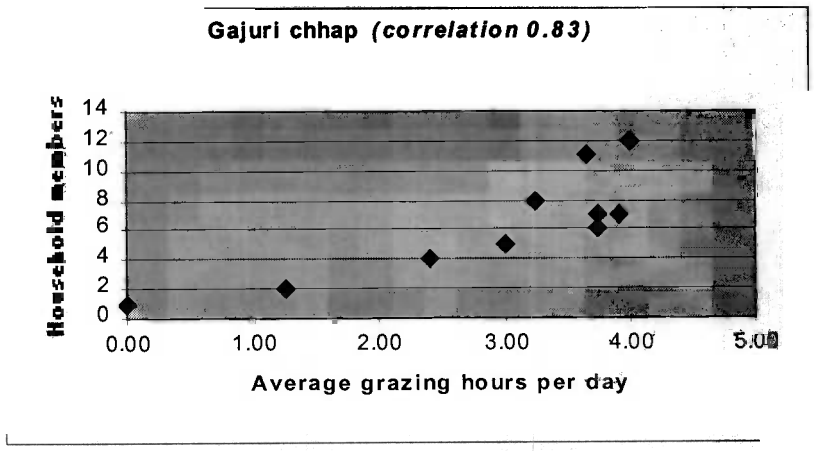


Fig. 1: Labour availability for grazing in Gajuri Chhap

3.3 Collection of fodders from on- and off-farm sources

Most households obtained more than half their fodder from on-farm sources. In Ange and Tawari, over 75% and 90% respectively of fodder was farm-produced. All crop residue was produced on-farm, except in Chankhubesi and Ange where households purchased additional residues (see Table 4). Over half cut-grass was collected on-farm. Households in Gajuri Chhap and Gauthale had greater access to off-farm sources than in other villages. Generally a high proportion of tree fodder was collected on-farm (over 70%), except in Gauthale where forest was still accessible. In most villages, over 80% of grazing fodder was from off-farm sources, except in Ange where the little grazing practised was mainly on-farm since the local communal grazing areas were closed.

Table 4 Percentages of fodders derived from on-farm sources in survey villages

	Gajuri Chhap	Gauthale	Chan-khubesi	Tawari	Ange
	Percentage of fodders collected on-farm				
Crop residue	100	100	75	100	84
Cut grass	52	55	71	71	82
Tree fodder	88	44	72	95	89
Grazing	15	5	16	10	77
Overall fodders	64	51	68	78	92

1. Means estimated over all seasons and other factors in GLM AoV models; village effects highly significant ($p<0.001$)

Data derived from only those households reporting collection of the type of fodder

Seasonal patterns of fodder collection showed that, for each fodder type (and grazing), the collection of fodder off-farm was generally more practised in the dry seasons (see Figure 4, season effects significant at $p<0.001$ except for crop residues). Households thus appeared to preferentially use accessible on-farm resources or only used off-farm resources when the need was pressing.

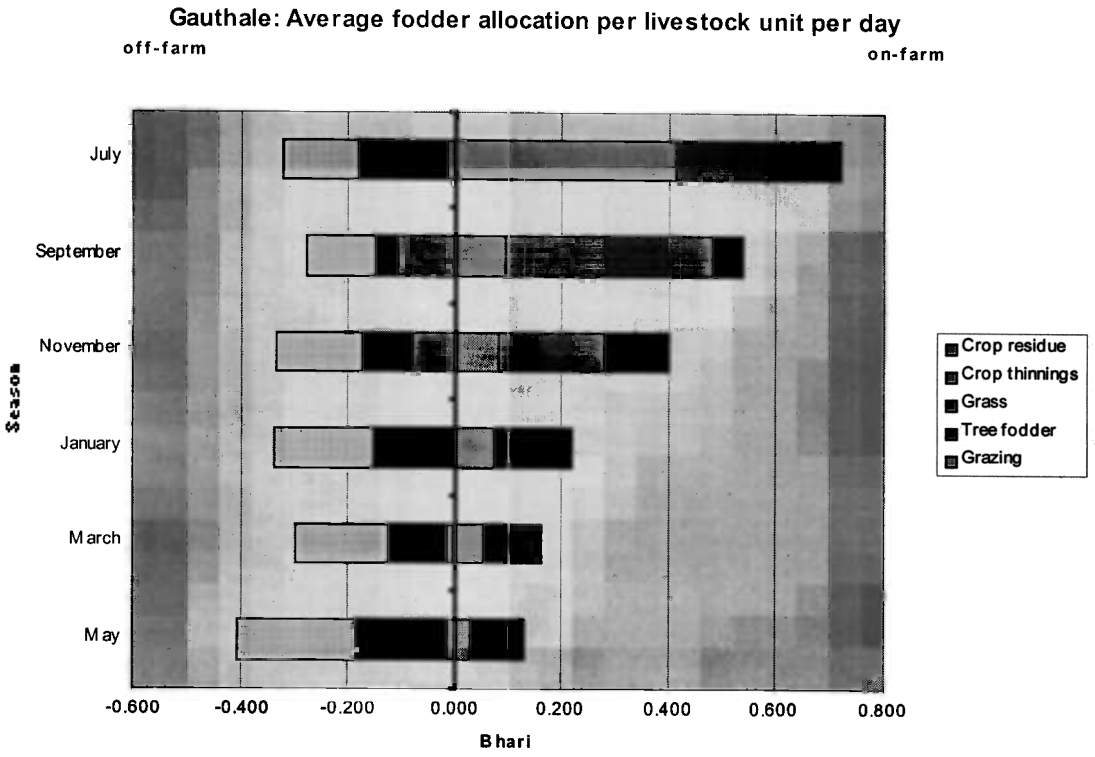
3.3 Access to off-farm fodder resources

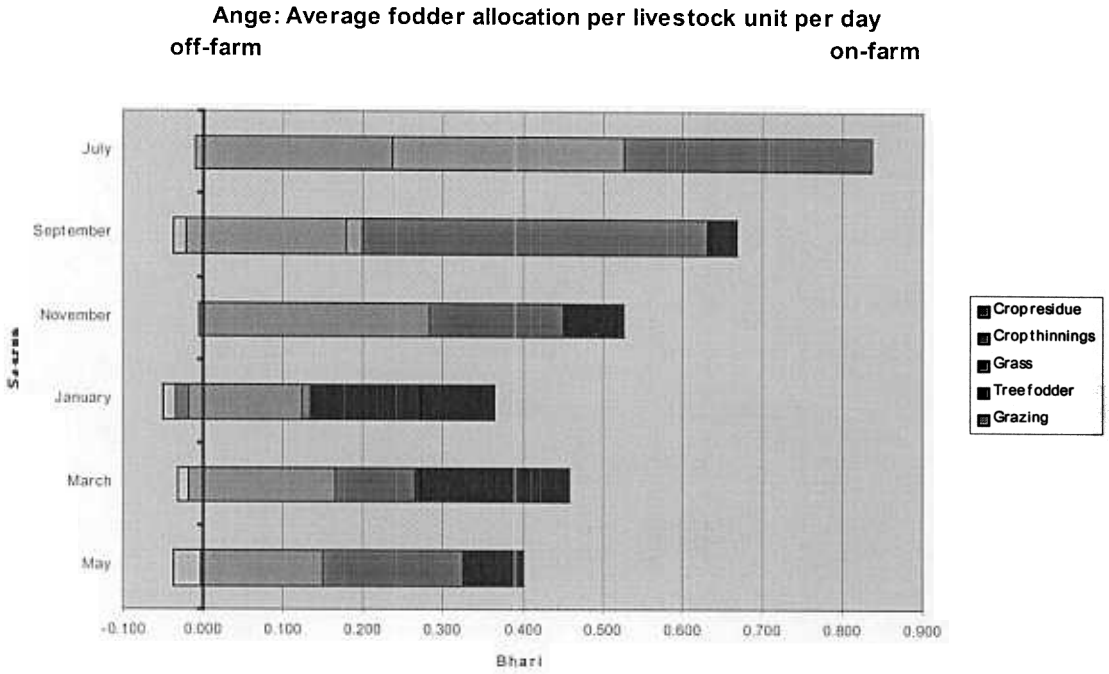
In addition to grazing, off-farm fodder sources include tree fodder from communal forests, grasses from forests and other communal land such as trail verges and straw purchased from local markets or neighbours. Access to each of these sources is determined mostly by location and is constant within a community. In this survey the Chankhubesi group included households from three communities on adjacent ridges. One of these communities, including four of the ten surveyed households, enjoyed access to a community forest area which consisted mostly of shrub and grass cover. Consequently these four households performed over 90% of all grazing activity recorded in all ten households over the survey period and collected over 95% of all off-farm tree fodder.

In the other four sites, all ten surveyed households within a village had equal access to off-farm fodder sources. Gajuri Chhap and Tawari households had access to a community forest and Gauthale households used a nearby forest for grazing and fodder collection without yet having agreed a handover of the forest from the District Forest Office. To collect off-farm tree fodder and grasses, Tawari villagers had to walk over an hour to reach the forest but communal grazing areas were abundant nearby. The forests used by Gauthale and Gajuri Chhap were both within ten minutes walk from any part of the village. The villagers in Ange had signed a handover agreement for the forest adjacent to their community soon before the commencement of this survey. The agreement banned the use of the forest for grazing or fodder collection for a period of five years.

Figure 2 compares the compositions of fodder supplied to livestock over six surveys in Gauthale and Ange, which have the highest and lowest proportions of off-farm fodder resources respectively. The difference in balance between on-farm and off-farm resources can be clearly seen in the figures. The main strategy employed by farmers in Ange to offset the absence of off-farm sources is year-round storage and use of crop residues. Rice straw is fed all year round, supplemented by maize stover and cob sheaths in September, millet straw in January and wheat straw in May. The proportion of crop residues out of total feed offered to livestock is higher in Ange than all other villages. Purchased straw is the only off-farm resource for the majority of households, but this is not readily available at all seasons.

Fig. 2:


Gauthale: Average fodder allocation per livestock unit per day
off-farm
on-farm
July
September
November
January
March
May
Season
-0.600
-0.400
-0.200
0.000
0.200
0.400
0.600
0.800
Bhari
Crop residue
Crop thinnings
Grass
Tree fodder
Grazing


Ange: Average fodder allocation per livestock unit per day
off-farm
on-farm
July
September
November
January
March
May
Season
-0.100
0.000
0.100
0.200
0.300
0.400
0.500
0.600
0.700
0.800
0.900
Bhari
Crop residue
Crop thinnings
Grass
Tree fodder
Grazing

Farmers in Chankhubesi are close to a large market town and purchase a significant amount of straw in January and March, about 30% of their total crop residue supply in these months. These farmers and those in Tawari also store the majority of their on-farm crop residue supply for use in the dry season but few households can produce enough to last until May. In Gauthale and Gajuri Chhap farmers store only small amounts of crop residue to bulk up feed for ruminants during the dry season. Most straw in these villages is fed within weeks of being produced. Only in Ange does the lack of alternative sources necessitate long-term storage of crop residues to ensure supply for the whole year.

Gauthale and Gajuri Chhap are similar communities in terms of altitude and climate and located in adjacent VDCs in Dhading district. However, the pattern of off-farm fodder use between the villages is distinct. Most households in both villages graze their livestock regularly all year round but collection of tree fodder from forest areas is minimal in Gajuri Chhap. Farmers in Gajuri Chhap are bound by restrictions in community forest agreements regarding the collection of forest fodder. However, they collect on average over twice as much fodder from trees on private land than the Gauthale villagers and are more knowledgeable about the ecology and management of the local fodder producing species (see below).

3.3.2 **Factors affecting collection of on- and off-farm fodders**

Apart from the village and seasonal effects noted above, the source of fodder was also related to various factors of household circumstances, particularly to household size (as shown in Table 5). Overall, the percentage of fodder collected on-farm decreased at the highest household size ($p< 0.05$) (ie the percentage collected off-farm increased). A similar pattern was evident for cut grass and tree fodders, suggesting that labour availability in the larger households might be a factor in accessing off-farm fodders. Conversely, the percentages of crop residues collected on-farm increased with household size ($p<0.09$), as if larger households did not need to purchase residues.

Table 5 Effect of household size on the percentage of fodders collected from on-farm sources

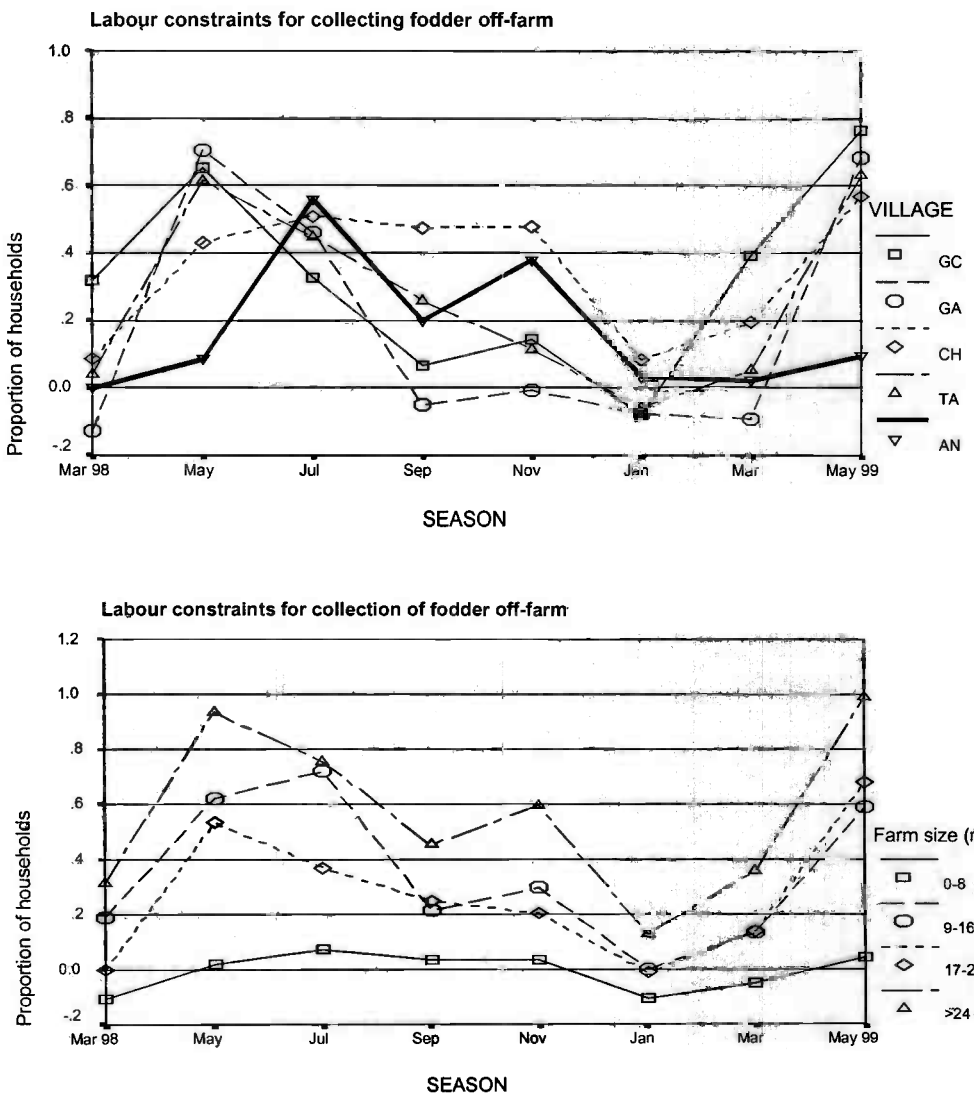
	Mean and (se), % fodder collected on-farm(1)				
Household size	**Overall fodders**	**Crop residues**	**Cut grass**	**Tree fodders**	**Grazing**
	x	p=0.09	ns	xx	ns
1-3	71.6 (4.3)	88.2 (3.8)	69.6 (5.5)	73.6 (4.8)	14.2 (10.1)
4-6	78.2 (3.5)	91.5 (2.1)	66.2 (3.1)	86.1 (2.7)	23.9 (6.6)
7-9	75.6 (3.5)	95.3 (2.8)	68.7 (4.5)	78.1 (3.5)	23.8 (5.7)
>9	63.8 (3.8)	99.4 (3.0)	60.2 (4.5)	71.4 (3.6)	25.0 (4.9)

1. Means estimated in GLM AoV models

x, xx and xxx = F ratio for effect of household size in AoV significant at $p<0.05$, $p<0.01$ and $p<0.001$ respectively: ns = not significant

There were trends for the source of fodder also to be related to land and livestock holdings (though not statistically significantly). Households with the smallest livestock holdings (and least fodder need) and the largest land holdings (greatest home production of fodder) collected the highest percentages of overall fodders on-farm. In association with these trends, the source of fodders was also related to the composition of land holdings (as expressed by the percentage of khet land) and the composition of the livestock holdings (% cattle in the LU holdings). Households with higher percentages of khet land collected a higher percentage of crop residues and cut grass on-farm but less grazing ($p<0.001$, $p<0.1$, and $p<0.01$ respectively). Households with a higher percentage of cattle and higher milk sales had available greater proportions of cut-grass on-farm ($p<0.01$) but also purchased more off-farm crop residues.

Figure 3 Seasonal patterns of reported labour constraints for fodder collection off-farm in different villages



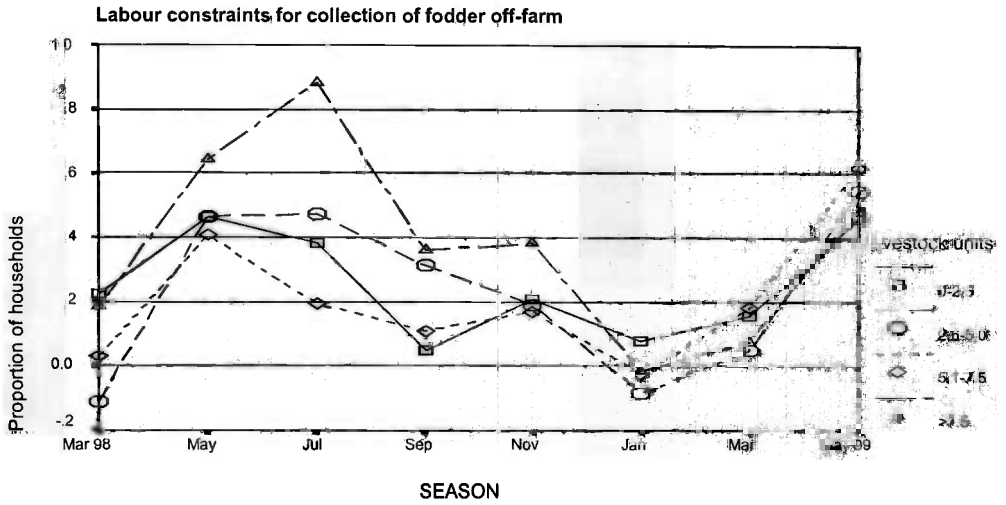
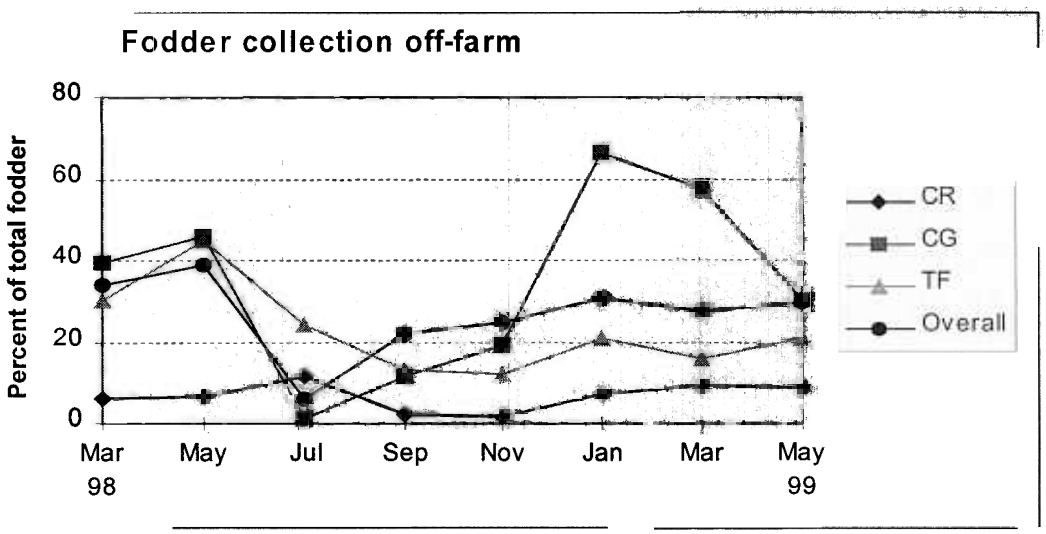


Figure 4 Seasonal patterns of collection of fodders off-farm



3.4 **Local knowledge of fodder tree species**

Tree fodder use as a proportion of total feed offered to livestock varied widely between research sites and with seasons (see Table 6). As described above, the availability of tree fodder from both on- and off-farm sources is of great importance in the dry season in particular. The variety of species available and the level of farmers' knowledge regarding the management of these species can therefore have a significant impact on the quality of livestock diets in the periods of greatest fodder shortage.

Table 6: Tree fodder use as a percentage of total volume of feed offered to livestock

Season	*Gajuri Chhap*	*Gauthale*	*Chankhubesi*	*Tawari*	*Ange*
July	2.4	15.8	4.6	18.2	0.0
September	16.6	11.6	12.5	2.8	5.2
November	22.7	28.8	23.5	21.5	14.4
January	53.9	52.7	24.1	53.2	56.0
March	46.4	46.4	9.1	46.5	39.5
May	61.0	50.4	31.1	51.2	17.2

Tables 7 and 8 give details of the most widely collected tree fodders over all five surveyed villages. A total of 85 different species were recorded as being collected by at least one household in at least one season over the survey period. The variety of species used, from both on-farm and off-farm sources, ranged from 41 in Gauthale and 39 in Gajuri Chhap to just 9 in Ange, reflecting the relative ease of access to tree fodder resources as a feed component within these villages. From the tables it can be seen that a select few species have particular importance for local fodder supplies. Only *Ficus semicordata* is available in all areas and is by some way the most prolific source of local tree fodder. The first six species in the list account for over 50% of all tree fodder collected over the whole year in the five villages combined. However, different species have significance at the local level. Farmers in Tawari village, for instance, were recorded as being heavily dependent on only three species throughout the year (*Ficus neriifolia, F. auriculata* and *Sauraria nepalensis*), despite using tree fodder in comparable proportions to Gajuri Chhap and Gauthale during the dry seasons (see table 6). The tables also highlight differences at the household level. In Chankhubesi *Morus alba* and *Grevillea robusta* were each harvested by only two households over the survey period. For the households concerned, these species made up a significant proportion of their total annual tree fodder supply.

The village workshops included discussions designed to ascertain the level of local farmers' knowledge regarding the management of local tree fodder resources, particularly concerning the possibilities of altering lopping regimes to provide fodder during the periods of fodder deficit in the dry season. Villagers from Chankhubesi and Ange do not maintain high levels of tree fodder supply during the late dry season between March and May. The workshop discussions confirmed that their knowledge of local fodder tree management was scant, with no suggestions forthcoming regarding alteration of lopping

regimes and few species mentioned without prompting from the research team. In the other three villages, however, a wealth of information was revealed on a wide variety of species *(Vickers, Chhetri, Basukala, Kiff, Amatya, Regmi, May '00)*. At Tawari, in particular, the range of local farmers' knowledge extended well beyond the three species mentioned above. The farmers have adjusted the lopping of *F. auriculata* so that it can be cut twice per year, in the early dry and late dry periods. They believe this regime offers the maximum output. Lopping of *F. neriifolia* and *F. semicordata* is managed so that some trees are cut in the early dry and some in the late dry to early monsoon period. More trees are left for the dry season if other fodder sources are projected to be more scarce than usual.

Farmers in Gauthale gave details of lopping regimes for 16 of their major fodder tree species. They demonstrated how various species were managed to cover different periods of the dry season. *Bauhinia purpurea, Ficus lacor* and *Litsea monopetala* are generally saved for the late dry season in April to May. Several other species (*Ougenia dalbergioides, Grewia subinaequalis, F. semicordata, Garuga pinnata*) can be cut twice a year, mature leaves in September to November and younger branches or leafy shoots, which have higher protein content, in the late dry season, without adversely affecting the following year's productivity. *Bridelia retusa* and *Spermadictyan suaveolens* are cut only once a year, usually between January and March, after which they shed their foliage and cannot be cut again for another year. Lopping of *Terminalia bellerica* is performed at the first sign of leaf fall so that farmers avoid feeding immature leaves to cattle, which can cause premature abortion. *Ficus hispida* is often subject to insect attack after November, which degrades the fodder quality. If the insects could be controlled this species would also be a suitable candidate for late dry season lopping.

Farmers in Gajuri Chhap provided more examples of adjustments to lopping regimes and, in some cases, management of the same local species differed from that practised in Gauthale. There is no insect problem with *F. hispida* which used to be cut before November, as in Gauthale. However, in recent years farmers have delayed lopping this species until April or May as a valuable feed supplement during the deficit period. Farmers also described how the lopping time for individual trees of species *B. purpurea, B. retusa* and *Terminalia chebula* can be adjusted incrementally over time. They also described two options for lopping *L. monopetala*. Most of these trees are cut before March, when leaf fall occurs. However, if a tree is not cut before leaf fall, the new shoots can be collected as fodder in April to May. As in Gauthale, most farmers also cut *Ficus religiosa* in the late dry season, which is not permissible for stricter followers of Hinduism. Farmers in Gajuri Chhap described a way to harvest fodder from the same branches in both March and May. Only if the branches are stripped of leaves by hand in March, rather than cut using a sickle, can the new leaf shoots also be used for fodder.

The information on local fodder tree management techniques was not collected from individuals but from group workshop discussions and cannot therefore highlight differences in knowledge within the villages. Farmers in Gajuri Chhap, with their broad knowledge of local species, are in the best position to manage tree fodder for reducing the dry season feed deficit.

Table 7: Major local fodder tree species in order of annual recorded use in study area

Rank	Species name		Total no of HH using	Usage (Bhari*/ household/ year)	Annual use in study area (Bhari)
	Nepali	Latin			
1	Khanyu	*Ficus semicordata*	40	69.12	2765
2	Timila	*Ficus auriculata*	18	83.52	1503
3	Kutmiro	*Litsea monopetala*	33	44.15	1457
4	Dudhilo	*Ficus nerifolia*	11	120.48	1325
5	Gogan	*Sauraria nepalensis*	13	93.67	1218
6	Tanki	*Bauhinia purpurea*	23	48.64	1119
7	Sal	*Shorea robusta*	12	58.27	699
8	Bakhre	*Spermadictyan suaveolens*	20	34.12	682
9	Sajh	*Terminalia alata*	12	56.45	677
10	Pati	*Buddleia asiatica*	21	25.60	538
11	Barro	*Terminalia bellerica*	13	31.97	416
12	Kavro	*Ficus lacor*	14	29.59	414
13	Painyu	*Prunus cerasoides*	13	30.73	400
		Adina cordifolia	12	32.86	394
		Ficus hispida	13	28.54	371
16	Gayo	*Bridelia retusa*	17	20.94	356
17	Sindhure	*Malotus philippensis*	13	27.09	352
18	Muhni	*Caryopteris odorata*	14	20.86	292
19	Birale	?	10	28.77	288
20	Gideri	*Premna barbata*	12	18.86	226
21	Banmara	*Eupatorium spp.*	14	13.40	188
22	Lahare		11	16.73	184
23	Bakaino	*Melia azedarach*	7	24.05	168
24	Dabdabe	*Garuga pinnata*	9	18.62	168
25	Guelo	*Callicarpa arborea*	9	17.80	160
26	Kurilo	*Asparagus spp.*	6	25.90	155
27	Thinke	?	10	13.78	138
	Katus	*Castanopsis indica*	10	12.19	122
29	Chieuri	*Aesandra butyracea*	5	20.81	104
30	Harro	*Terminalia chebula*	8	12.66	101
31	Pipal	*Ficus religiosa*	10	9.25	92
32	Kangiyo	*Grevillea robusta*	3	30.72	92
33	Dhagerro	?	9	9.83	89
34	Kimbu	*Morus alba*	3	26.36	79
35	Dhumre	*Ficus racemosa*	9	8.75	79
36	Hathi paile	*Brassiopsis spp.*	4	18.78	75
37	Sandan	*Ougenia dalbergioides*	5	13.72	69
38	Nimarro**	*Ficus auriculata*	4	14.45	58

*Bhari = local measurement. 1 bhari = 1 backload = 36 kg. approx.

** Nimarro and Timila (no. 2), both *Ficus auriculata*, usually assumed to be identical by researchers and farmers alike. However, some farmers in Chankubesi identified differences between them

Table 8: Location and season of use of major tree fodder species

Species name		Villages (greatest use first)	Season of fodder availability
Nepali	Latin		
Khanyu	*Ficus semicordata*	GC, GA, AN, CH, TA	Year round
Timila	*Ficus auriculata*	TA, CH	Year round
Kutmiro	*Litsea monopetala*	AN, CH, GC, GA	Year round
Dudhilo	*Ficus neriifolia*	TA, CH	Year round
Gogan	*Sauraria nepalensis*	TA, CH	Year round
Tanki	*Bauhinia purpurea*	GC, GA, CH	All dry
Sal	*Shorea robusta*	GA, GC, CH	Year round
Bakhre	*Spermadictyan suaveolens*	GA, GC	Early dry
Sajh	*Terminalia alata*	GA, GC	All dry
Pati	*Buddleia asiatica*	AN, CH, TA	Year round
	Terminalia bellerica	GA, GC	All dry
Kavro	*Ficus lacor*	GC, GA	Late dry
Painyu	*Prunus cerasoides*	CH, TA	Year round
Karam	*Adina cordifolia*	GA, GC	Year round
Khasreto	*Ficus hispida*	GC, GA	All dry
Gayo	*Bridelia retusa*	GC, GA	All dry
Sindhure	*Malotus philippensis*	GA, GC	Mid dry
Muhni	*Caryopteris odorata*	GA, GC	Year round
Birale	*?*	GA	Monsoon
Gideri	*Premna barbata*	GC, GA	All dry
Banmara	*Eupatorium spp.*	CH, AN, GC	Year round
Lahare	*?*	GA, CH	Year round
Bakaino	*Melia azedarach*	CH	Year round
Dabdabe	*Garuga pinnata*	GA, GC	All dry
Guelo	*Callicarpa arborea*	GA, GC	Mid dry
Kurilo	*Asparagus spp.*	GA, GC	Monsoon
Thinke	*?*	GA, GC	Mid dry
Katus	*Castanopsis indica*	CH, AN, TA	Late dry
Chieuri	*Aesandra butyracea*	GA, GC	Late dry
Harro	*Terminalia chebula*	GC, GA	Mid dry
Pipal	*Ficus religiosa*	GC, GA	Late dry
Kangiyo	*Grevillea robusta*	CH, GA	Late dry
Dhagerro	*?*	GA, GC, CH	Early dry
Kimbu	*Morus alba*	CH, GC	Year round
Dhumre	*Ficus racemosa*	GC, GA	Late dry
Hathi paile	*Brassiopsis spp.*	TA	Mid dry
Sandan	*Ougenia dalbergioides*	GA	Late dry
Nimarro	*Ficus auriculata*	CH, TA	Early dry

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Gogan	*Saurauia nepalensis*	TA, CH	Year round
Tanki	*Bauhinia purpurea*	GC, GA, CH	All dry
Sal	*Shorea robusta*	GA, GC, CH	Year round
Bakhre	*Spermadictyon suaveolens*	GA, GC	Early dry
Sajh	*Terminalia alata*	GA, GC	All dry
Pati	*Buddleia asiatica*	AN, CH, TA	Year round
Barro	*Terminalia bellerica*	GA, GC	All dry
Kavro	*Ficus lacor*	GC, GA	Late dry
Painyu	*Prunus cerasoides*	CH, TA	Year round
Karam	*Adina cordifolia*	GA, GC	Year round
Khasreto	*Ficus hispida*	GC, GA	All dry
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4. Conclusions

The factors investigated in this paper are by no means an exhaustive list. However, several conclusions can be made about the way in which individual households manage their fodder resources over the seasons.

Taken individually, the size of livestock holdings, size of landholdings and labour availability all have clear correlations with the total amount of fodder collected by a household in the survey villages. However, only by considering the combined effect of all these factors can an estimate be made of the likely total fodder supply over the year. The survey included households with a wide combination of livestock, land and labour resources which allowed meaningful analysis of the interaction of these factors to be made (see accompanying paper). It is clear that above a certain level of labour and landholdings, the number of livestock units held ceases to become a limiting factor for year round fodder supply. Conversely, at the low end of land resources and family size there is a point at which year round fodder supply becomes almost impossible. These threshold values may be estimated from the data collected, allowing for a degree of error. However, the survey decisively established that a general pattern exists for households within these extremes of increased fodder supply with increasing resources and decreased fodder collection per livestock unit with increasing livestock holdings.

These household level relationships cannot be directly translated from village to village. Access to off-farm sources of fodder has a very clear impact on the levels and type of fodder that any household in a particular community can collect. The comparison of seasonal fodder compositions in Gauthale and Ange villages suggests that, if access to local forests were to be restricted in the near future, farmers in Gauthale would experience severe shortages of fodder, resulting in a dramatic change in the composition and quality of livestock feed. Farmers in Gajuri Chhap and Tawari have more abundant grass and tree fodder resources on farm and would consequently be able to maintain their current levels of fodder collection in the event of a squeeze on forest resources.

As a result of their greater dependence on forest resources, farmers in Gauthale are less knowledgeable about the possibilities of altering the management strategies of local fodder trees than their counterparts in Gajuri Chhap. However, the information gleaned from farmers in both these villages could be of great benefit to the Ange community, where many of the same species could be maintained on private land. The key to improving fodder collection strategies lies in increasing the range of fodder types available, as farmers in Gajuri Chhap have discovered. They are able to exploit the fodder trees in their local area to cover the majority of their total fodder supply in the dry season, eliminating the need for costly storage of straw and other crop residues.

For the majority of households, the size of land and livestock holdings are relatively constant over time. Initiatives for improving the quantity and quality of fodder collected for livestock should therefore concentrate on the constraint of labour availability for

grazing and off-farm fodder collection. The greatest potential for targeted improvements in fodder collection strategies therefore lies with those households with medium levels of livestock, land and labour resources whose current supply of fodder can be supplemented by the development of on-farm agroforestry. For the smallest households, agroforestry initiatives can go only some way to supplementing fodder supply. Other external sources may be explored, such as purchased fodder in areas near market centres such as Chankhubesi, but only where commercial livestock farming is viable. The data from this survey indicates that detailed analysis of current resources can lead to a reliable estimate of the type of fodder required and the potential for on-farm development. Planting of grass and tree fodder species on private land, where sufficient land is available, can reliably lead to the reduction of labour as a constraint to fodder collection in the short term. In addition, a concerted approach by the farmers themselves to experiment and explore the possibilities of local tree species for provision of fodder in the dry season must be encouraged in conjunction with any external development efforts.

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