**DEPARTMENT FOR INTERNATIONAL DEVELOPMENT**
***STRATEGY FOR RESEARCH ON RENEWABLE NATURAL RESOURCES***

**LIVESTOCK PRODUCTION PROGRAMME**

***FINAL TECHNICAL REPORT***

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| DFID Project Number | **R6994** |
| Project title**:** | **Improved strategies for on-farm fodder production during the dry season, using participatory research techniques.** |
| Project Leader | **Liz Kiff** |
| Organisation | **Natural Resources Institute, University of Greenwich** |
| LPP Production System | **Forest agriculture interface and hillsides production systems** |
| Period of DFID funding | **01.09.1997 to 31.11.2000** |

**CONTENTS:**

## 1. EXECUTIVE SUMMARY

The project purpose has been to develop strategies to improve the seasonal availability of feeds in small-scale livestock production in forest-agriculture interface production systems in order to maintain and enhance livestock productivity and hence overall farm productivity.
This has been addressed through research conducted within some of the most closely integrated and interdependent examples of livestock/crop/forest farming systems; those found in the mid-hills of Nepal.

The purpose has been achieved by working collaboratively with local farmer groups and their supporting non-government organisations (NGOs), using an action-research approach. In this approach, farmer cross-visits and training in fodder cultivation and management were held in response to findings and issues raised during the investigation of present fodder collection practices and use.
Research activities were conducted at five contrasting sites in the mid-hills, selected to represent different altitudes (low, mid and high) and distance from market (close and far). Working closely with local communities and supporting local NGOs, bi-monthly surveys were conducted over 18 months with 10 farmers at each site; representative of a range of land and livestock resource backgrounds. Fodder collection and allocation to different livestock as well as farmer perceptions of deficits were recorded. Group meetings and key informant discussions were held to investigate patterns and trends in fodder resource use and availability in the different areas.
Institutionally, the project was jointly run with a national NGO, Nepal Agroforestry Foundation (NAF) and the government Department for Forest Research and Survey (DFRS). This was the first project of its kind within DFRS and conducted by NAF, involving collaborative work between a government department and NGO.

The research outputs are:
1. The measurement of the relative importance of on-farm and off-farm fodder resources in terms of quantity, quality and seasonal variability, for farmers with different livestock and land holdings.
2. The identification of trends in the availability of on-farm and off-farm sources of fodder, and the effect of new policies such as Community Forest Management agreements on supply of off-farm fodder and grazing resources.
3. The identification of sustainable systems of fodder production to overcome constraints in supply.
4. The provision of fora for the discussion of findings and related work in-country between farmers and between research and extension practitioners.
5. The identification of key policy implications.

The outputs from the project contribute both materially and non-materially toward the UK Department of International Development (DFID) goals in terms of addressing poverty, contributing towards social and human development, and to environmental sustainability and regeneration. Poverty is directly addressed through the increase in livestock production (milk, meat and manure), in terms of improving income generation, savings, family health and crop production through soil fertility maintenance. The development of self-financing women's groups, active in fodder resource development at household and village level, has important implications for community development, and women's autonomy and empowerment. The reduction in free grazing introduced as a result of increased private cultivation of fodders is important in halting the tendency for forest to pasture conversion that contributes to environmental degradation in the mid-hills.

## 2. BACKGROUND

In Nepal, shortages or poor quality of fodder at the end of the dry season in March-June lead to poor condition and weakness in animals, just when animal power is required for cultivation. In the largely organic-based farming system in the hills, manure produced by animals is vital for the maintenance of soil fertility. A decrease in soil fertility has been linked with decreasing numbers of livestock kept in certain areas which in turn has been caused by the lack of readily-accessible fodder (Sthapit *et al*., 1988).

Traditionally, fodder has been gathered in the form of tree leaves and grasses from common property forest areas, which are guarded and managed by the local community. These off-farm sources are particularly important in the dry season, providing a high-protein supplement to low-protein crop residue-based diets. A small amount of tree fodder is harvested on-farm from planted trees, protected wildings, woodlots or, more commonly, from terrace risers and field boundaries. Studies show an increase in on-farm cultivation of fodder trees associated with diminishing community forest resources (Carter and Gilmour, 1989). More recently, the tightening of rules with regard to access to community resources has necessitated more on-farm cultivation of fodder, both in terms of grasses and trees (personal obs., February. 1996). As traditional community resources diminish, the labour and time required to collect fodder from off-farm sources increases and, hence, the cost/benefit ratio for private cultivation increases.

Many NGOs, including member organisations of the umbrella grouping Nepal Agroforestry Foundation, are actively involved in the promotion of private tree and fodder cultivation through support and training for the running of local private and community nurseries. Their activities are in response to a certain demand from some smallholder farmers for suitable planting materials. While increasing private cultivation of fodder is an option, and possible solution for some farmers, it is unclear whether this is feasible for the amounts of fodder required for all farmers. The degree to which fodder deficits are due to a shortage of basal feeds and /or high protein supplements will be investigated. The project will explore these questions and look at the potential for improving fodder supply using both on- and off-farm sources of fodder.

As farmers grow more fodder trees and grasses on, or close to, their cultivated land they seek advice as to how best to manage the fodder to obtain maximum amounts at the required time each year, while minimising adverse affects on adjacent crop growth. Research under this project will build on a previous livestock project investigating strategies for the allocation of various feed resources to optimise livestock production (Thorne *et al*., 1999). It will also tie-in with a previous country-wide survey of farmer knowledge and perceptions about tree fodder (Upadhyay, 1991), indigenous technical knowledge of farm tree management and use in the mid-hills (Thapa, *et al*. 1995), and with fodder tree species trials started by the Forest Research and Survey Centre in collaboration with the above NGOs and Lumle and Pakhribas Agricultural Research Stations in 1992 (Amatya and Kiff, 1994). Starting with current practice of fodder collection by farmers, the source and timing of fodder supply will be noted together with assessment of the nutrient content of the combinations of trees, grasses and legumes used. Previous research indicates that it is not just a shortage of feed sources, but a shortage of protein-rich feed that is a constraint to production. Legumes contain higher levels of protein than grasses, and tree fodder in general contains in excess of 200g/kg of crude protein, a balancing supplement to crop residues containing only 20-30 g/kg crude protein that are fed during the dry season (Thorne et al., 1999).

There are two non-biological advantages to on-farm fodder cultivation; labour saving at peak work times in the year and reducing the risk in collection of tree products. Accidents incurred whilst collecting tree products, particularly fodder, is the most common cause of injury in rural areas in Nepal. Seasonal labour shortages around planting and harvesting are common so that on-farm, easily-accessible fodder resources are especially valuable during these times (Kiff 1991). Farmer assessment of the importance of these factors in their choice of fodder supply will be included in the analysis.

Larger landowners can afford to set aside some land for fodder and tree production, thus avoiding potential competition with crops and making protection of the young trees, grasses/legumes easier. Larger land holdings also enable farmers to be less dependent on off-farm resources. Farmers with limited land resources cannot afford to take land out of crop production in this way. Thus, for smallholder farmers, integrated tree/grass/legume/crop systems are of particular relevance, and it is towards them that this project is directed.

The project will be based in Khabre district where NAF and some of its associate organisations have been active for over 10 years. Communities within the district include those with good access to the nearby markets of Dhulikel, Bhaktapur and Kathmandu and more isolated settlements with little outside interaction or contact.

## 3. PROJECT PURPOSE

To develop strategies to improve the seasonal availability of feeds in small-scale livestock production in forest-agriculture interface production systems in order to maintain and enhance livestock productivity and hence overall farm productivity.
The project worked collaboratively with local farmer groups and their supporting NGOs to investigate present fodder collection practices and use. Employing an action-research approach, the training of farmers in fodder cultivation and management was conducted alongside research into present feed practices. Institutionally, the project was jointly run with a national NGO, Nepal Agroforestry Foundation and the government Department for Forest Research and Survey. This was the first project of its kind within DFRS, and conducted by NAF, involving collaborative work between a government department and NGO.

## 4. RESEARCH ACTIVITIES

### *4.1.1 Identification of four contrasting study sites in a suitable area of the mid-hills of Nepal.*

Initial field visits were conducted to 12 sites in Kavrepalanchok, Sindhupalchok and Dhading districts by NAF staff, **Report 1**. These were sites where local farmers and/or NGOs had requested assistance from NAF in initiation and support of local development activities. From the information gathered on the nature of perceived fodder deficits, community interest, strength of community action and the following criteria, five research sites were selected, **Report 2**.

### *4.1.2 Site selection was based on the following criteria:*

a) Areas in which NAF or associated NGOs are active.
b) Communities involved in Community Forestry Management (CFM) initiatives for over a year.
c) Communities that identify fodder supply as a constraint to farm production.
d) The original intention to select the same, or closely associated sites to Beer Kurka, Kyoul and Phalaxseela, where an identification of fodder species and initial assessment of farmers fodder use was conducted by an Associate Professional Officer attached to DFRS, was ammended. It was decided that a greater range of altitudes needed to be covered than possible at these sites and that all sites should experience the same amount of external inputs (i.e. not have been the focus of previous research activities). Consequently alternative sites were chosen during field visits by NAF staff in the first two months of the project.

The five research sites selected (Table 1) consisted of two at low altitude (<1000m), two at mid-altitude(1000-1500m) and one at higher altitude (1750m). Sites were also differentiated by their distance to the nearest market.

*Table 1 Research Sites*

| Village name | District | Altitude | Closeness to market |
|---|---|---|---|
| Gajuri Chhap | Dhading | Low | Close |
| Gauthale | Dhading | Low | Distant |
| Chunkhubesi and Nayagaun | Kabre | Mid | Close |
| Ange | Sindhupalchok | Mid | Distant |
| Tiwari | Kabre | High | Distant |

Altitudes: Low < 1000m, Mid 1000m-1500m, High >1500m
Markets: Close (under 1hours walk), Distant (1.5+ hours walk)

***4.1.3 Generate community profiles for the five study sites in terms of household livestock type and number, land holding and overall wealth ranking.***

This activity was carried out by a multi-disciplinary team consisting of a farming systems agronomist and livestock feed specialist from NRI, a tree fodder specialist from FORESC, a socio-economist from NAF and two field staff with knowledge and experience of working with farmers in the area. The team worked with key village informants and local NGO representatives at each location. Techniques employed included key informant informal interviews, semi-structured individual interviews and group discussions, **Report 2**.

***4.1.4 Households representative of different resource profiles will be selected for the more in-depth evaluation of the use of on-farm and off-farm fodder sources and labour requirement for collection over the year.***

A large community meeting was held at each research site after production of the community profile.. At the meeting the aims of the proposed research were clarified, which included the need to work with representatives from different resource backgrounds. The local community was asked to suggest suitable households with which to work and, through a mixture of volunteering and election, ten households were selected in each location which covered the current range of land/livestock resource backgrounds, **Report 2**.

***4.2.1 Recent changes in availability and access to fodder sources together with the underlying causes of these changes were explored with key informants, collaborating farmers and through group meetings as necessary.***

Changes and trends in on- and off-farm supplies of different types of fodder (including grazing) were explored during the bi-monthly surveys, in group meetings and with key informants over the three years of the project. Access to these resources by different households and the implications of different access on resource and labour use were noted, **Reports 3,4 and 5**. Bi-monthly surveys were conducted with each of the 50 collaborating farmers to document their collection, allocation and estimated deficits in different feed types across seasons.

***4.2.2 The quantity, quality and seasonality of any fodder deficit faced by different resource-based farmers will be explored with the farming households. The increased fodder supply required to meet this deficit will be calculated and potential species/source combinations discussed with farmers.***

Farmer perceptions of fodder deficits were found to vary within and between villages. As the composition of diets changed markedly by season, it was difficult for farmers to estimate what animals could eat in a deficit season. There was fairly close agreement on what animals could eat of monsoon-available feeds (though sometimes farmers were unable to provide this amount due to labour constraints during the planting season). However, during fodder-deficit periods, potential appetite estimations varied to a greater extent as farmers had never actually been able to offer high levels of those types of feed.

***4.2.3 Production of report and preliminary fodder production strategies for testing.***

Compilation and summarisation of the bi-monthly survey data (18 months of data from 50 farmers at five different sites) took longer than envisaged, **Report 7**. Consequently, plans for on-farm experimental plots had to be made before these findings were available, **Report 5**.

***4.3.1 On-farm trials to test the improved strategies identified, including selected fodder species combinations, will be instigated with collaborating farmers.***

On-farm experimental plots were established by each of the 50 collaborating farmers. Species selected for testing contained some common to all sites, with a few specific to a limited number of sites according to altitude suitability etc. Planting material was largely produced locally, with a few species supplied from off-site where germination or growth on-site had been poor, **Report 6**. A statistician from NRI was involved in the planning of the design and in the final analysis of results from the trials (**dissemination output 20**).

***4.4.1 A series of workshops were be held at the end of the research project to provide fora for***

**a) discussions between members of farming households.**

These took the form of village-level workshops held at each research site, with participants invited from surrounding communities as well as the participating community.

**b) discussions between farming communities.**

A Kathmandu-based workshop was held where farmer representatives from each of the sites could meet and discuss experiences and adaptations/ adoptions of technologies to improve fodder supply and utilisation.

**c) –discussions between NGOs and research practitioners on the findings and other relevant work.**

A national-level workshop was held in Kathmandu and attended by 18 organisations involved in research, extension and policy development. Fourteen papers on various aspects of fodder research and development were presented, with discussions around core themes. Proceedings are in the process of being finalised and key papers will also be published as a special edition of the national scientific journal, Banko Janakari.

## 5. OUTPUTS

### 5.1. Measurement of the relative importance of on-farm and off-farm fodder resources in terms of quantity, quality and seasonal availability, for farmers with different livestock and land holdings

The five research sites differed in several ways with regard to average land holding, livestock holdings, access to fodder resources and the practice of grazing (Table 2). Total land holdings were highest in Gajuri Chhap and smallest in Chankhubesi and Ange, although Ange had the highest proportion of khet (bunded, irrigated land). A relatively low proportion of households had khet land in Chankhubesi and Tawari.

***Table 2 Average land and livestock holdings by households in survey villages***

| | Gajuri Chhap | Gauthale | Chan-khubesi | Tawari | Ange |
|---|---|---|---|---|---|
| **Household size** | | | | | |
| Average persons | 6.6 | 7.9 | 5.2 | 6.3 | 6.3 |
| **Land holdings** | | | | | |
| Total land area (ro) (1) | 23.7 | 13.4 | 11.6 | 16.5 | 12.3 |
| H'holds with khet (%) (2) | 90 | 80 | 50 | 50 | 100 |
| Khet land % total land | 17 | 12 | 14 | 8 | 52 |
| Trees on farm (n) | 49 | 31 | 36 | 18 | 29 |
| **Livestock holdings** | | | | | |
| Livestock units (3) | 7.4 | 7.7 | 3.3 | 4.1 | 5.0 |
| LU/land ropani (3) | 0.32 | 0.63 | 0.31 | 0.26 | 0.48 |
| Cattle %LU | 29 | 12 | 53 | 20 | 17 |
| Buffalo %LU | 35 | 42 | 23 | 46 | 58 |
| **Households grazing (%)** (4) | 75 | 80 | 40 | 62 | 27 |

1. Average land holdings in Ropani (20 ropani is equivalent to 1 hectare)
2. Khet is bunded, irrigated land.
3. One Livestock unit (LU) = one adult indigenous cow of 250 kg (buffalo = 1.5 LU, oxen 1.2 LU, goats 0.1 LU) (after Pradhan 1987); crossbreds 1.2 times indigenous species LUs
4. Households reporting any type of animal grazing in any season (converse = no animals ever grazing)

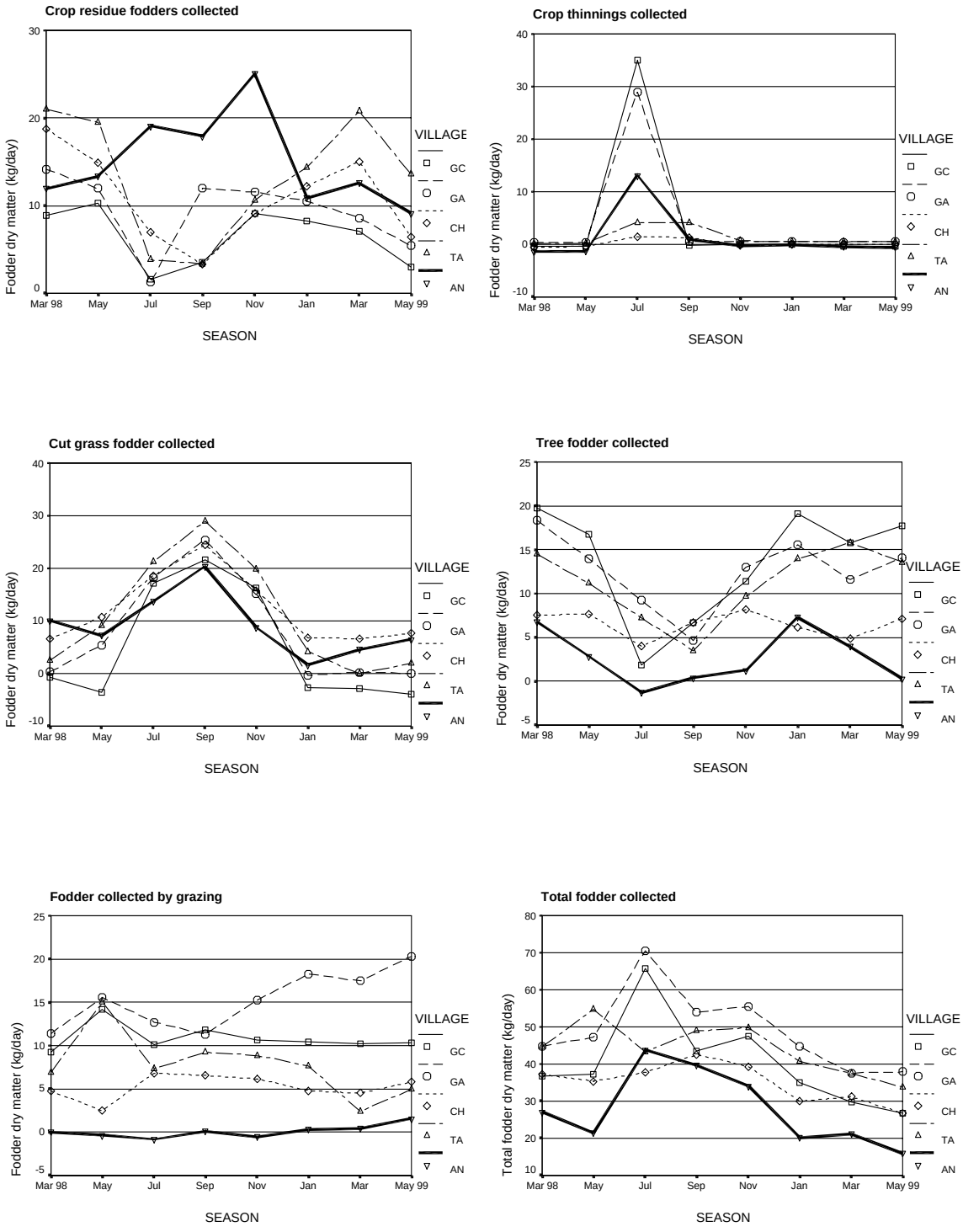
### *5.1.1 Fodder collection*

The expected seasonal patterns of feed collection were evident, with higher collections of cut grass and grazing fodder in the rainy season and of tree fodders and crop residues in the dry season. Fodder collection was positively associated with land holdings, tree holdings and household size (labour availability), as well as with livestock holdings (although collection rates were not sufficient for the larger livestock holdings). The quality of feeds collected was higher for households in villages where grazing was practised. Three different seasonal patterns of nutrient collection and content were noted between villages, with higher and less seasonal collection in Gajuri Chhap and Gauthale, more seasonal collection (low in the dry season) in Chankhubesi and Tawari, and low collection in the rainy season in Ange.

Fodder collection and nutrient availability within collected fodder are negatively related to livestock holdings (lower availability at higher holding sizes, $p<0.001$). Neither household size nor landholdings were significantly associated with nutrient content or collection rates per LU. However, trends were evident consistent with their effects on composition of collected fodders. For example, larger households tended to undertake a greater amount of grazing which in turn was associated with better quality feed. (Vickers *et al.*, 2000, **dissemination output 23**)

Composition and quantity of fodders collected by different villages in different seasons varied significantly (Fig. 1).

***Figure 1. Composition of collected fodders by season and village.***




Most notable was the very high proportion of crop residues in collected fodders in Ange (almost 50%) compared with around 30% for Chankubesi and Tawari and around 20% for Gajuri Chhap and Gauthale. This reflects the greater dependence on crop residues that occurs in diets, as access to grazing and off-farm fodder are reduced. The proportion of cut grass in the diet also increases, providing the crucial green component of the diet. Goats find this change in diet the most difficult, and a reduction in goat numbers kept is one of the most marked effects of reduced access to grazing and tree fodders.

Composition of crop residues differed between villages, with more rice and millet straw (tending to be of lower quality) being used in villages feeding higher proportions of crop residues.

### *5.1.2 Collection on-farm*

Most households obtained more than half their fodder from on-farm sources and in Ange and Tawari, this amounted to over 90% and 75%, respectively (Table 3). All crop residues were produced on-farm, except in Chankhubesi and Ange, where households purchased additional residues. Over half of the 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 as the local communal grazing areas were closed.

***Table 3. Percentages of fodders derived from on-farm sources in survey villages.***

| | **Gajuri Chhap** | **Gauthale** | **Chan-khubesi** | **Tawari** | **Ange** |
|---|---|---|---|---|---|
| | Percentage of fodders collected on-farm (%) (1) (2) | | | | |
| 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 ($p<0.001$)

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

Comparisons of on-farm production of fodder by land holding size across villages show that the amounts of crop residue collected increased with khet land holding (Table 4). This is understandable in the greater frequency of multiple cropping on khet land. Availability of cut grass increased with both rain-fed (bari) and khet land holdings (although statistically significantly only with khet). Amounts of tree fodder collected increased significantly only with bari land (most trees on farms occur on bari land).

***Table 4. Annual total collection of on-farm fodders by households with different land holdings.***

| | **Annual total collection on-farm ('000 kg DM) (1) Khet land holdings (ropani)** | | | | **Significance of effects (2)** | |
|---|---|---|---|---|---|---|
| **Bari land** | 0 | 0-5 | >5 | Overall | **Bari land** | **Khet land** |
| **Crop residues** | | | | | | |
| 1-6 | 2.8 | 2.7 | 6.9 | 3.3 | ns | p=0.06 |
| 6-12 | 2.5 | 4.3 | 5.8 | 4.2 | | |
| >12 | 2.4 | 2.9 | 4.0 | 2.9 | | |
| Overall | 2.6 | 3.5 | 5.3 | 3.5 | | |
| **Cut grass** | | | | | | |
| 1-6 | 2.9 | 2.8 | 2.7 | 2.8 | ns | xx |
| 6-12 | 3.0 | 4.7 | 3.0 | 4.0 | | |
| >12 | 3.8 | 3.6 | 5.6 | 4.1 | | |
| Overall | 3.3 | 3.9 | 4.0 | 3.7 | | |
| **Tree fodder** | | | | | | |
| 0-6 | 1.5 | 1.5 | 1.2 | 1.5 | xx | ns |
| 6-12 | 1.4 | 2.6 | 1.3 | 2.0 | | |
| >12 | 2.0 | 3.0 | 4.4 | 2.9 | | |
| Overall | 1.7 | 2.4 | 2.6 | 2.2 | | |

(1) Means estimated over all seasons and other factors in GLM AoV models,
(2) x, xx and xxx effects significant at $p<0.05$, $p<0.01$ and $p<0.001$ respectively; ns = not significant

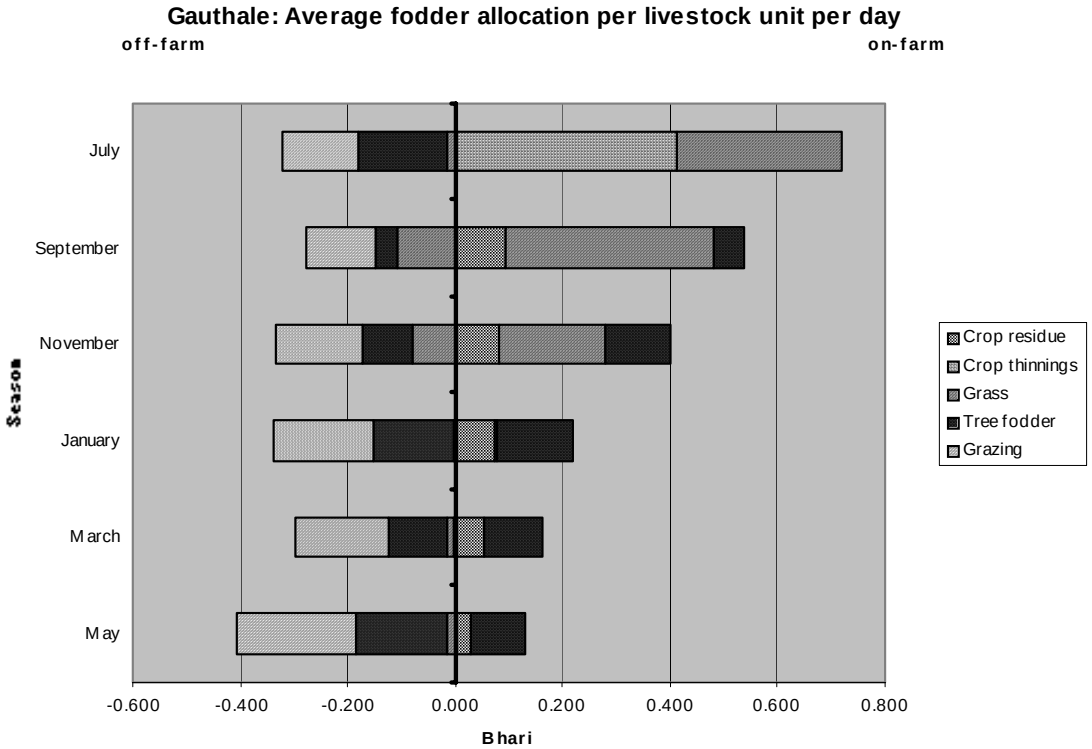
Seasonal patterns of fodder collection showed that, for each fodder type (and grazing), the collection of fodder off-farm was more common in the dry season (see Figure 2, season effects significant at $p<0.001$ except for crop residues). Thus, households appear to use preferentially accessible on-farm resources; using off-farm resources only when the need is pressing. An exception to this is the purposeful saving of some fodders for use during very busy planting periods in June/July and September by some households.

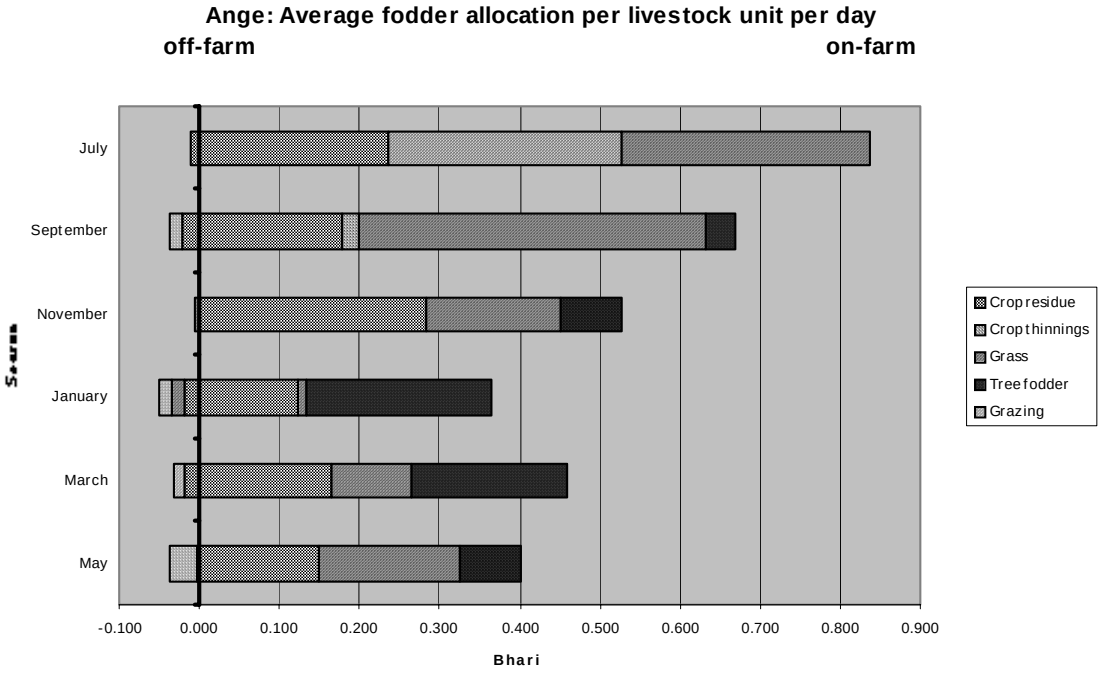
### *5.1.3 Off-farm collection*

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 and concentrates purchased from local markets or neighbours.

Figure 2 compares the composition of fodder supplied to livestock from 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 seen clearly 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, with slightly higher allocations of concentrates. Rice straw is fed throughout the year, supplemented by maize stover and cob sheaths in September, millet straw in January and wheat straw in May. The proportion of crop residues in the total feed offered to livestock is higher in Ange than all other villages.

***Fig. 2. Average fodder allocation per livestock unit per day at two sites.***






Overall, concentrates contributed about 6% to the total dry matter collected. The amount of concentrate available was similar through all seasons and unrelated to either household size or to land holdings. Concentrates fed per livestock unit was less in households with larger livestock holdings. Concentrates contributed over 11% of dry matter to diets in Chankhubesi and 7% in Ange; use of concentrates being positively correlated with amount of milk sales and khet holdings.
These differences in fodder composition have implications for the amount of nutrients present, nutrient density and, consequently, for livestock diets.

**Feed allocation to different livestock.**
Feed offered to milking cattle and buffalo differed depending on the sales of milk by households. Those which sold milk tended to feed more crop residues, cut grass and total fodders to both cattle and buffalo. This was highly significant in the case of concentrates, where approximately double the quantities were fed in milking households (Table 5).

***Table 5. Average daily feeds offered to cattle and buffalo in households selling or not selling milk.***

| | Feeds offered (kg DM/head/day) (1) | | | | | |
|---|---|---|---|---|---|---|
| | Cattle milk sales | | | Buffalo milk sales | | |
| | No | Yes | (2) | No | Yes | (2) |
| Crop residues | 3.34 | 3.68 | | 4.77 | 5.39 | |
| Crop thinnings | 0.56 | 0.61 | | 0.63 | 1.08 | |
| Cut grass | 2.67 | 3.33 | | 3.94 | 4.53 | |
| Tree fodder | 1.62 | 1.26 | | 2.18 | 2.40 | |
| Grazing | 1.10 | 2.08 | x | 0.10 | 0.03 | |
| Concentrates | 0.48 | 0.82 | x | 1.05 | 2.03 | xxx |
| Total fodders | 9.28 | 10.96 | p=0.09 | 11.62 | 13.44 | |
| Total feeds | 9.77 | 11.78 | x | 12.67 | 15.47 | x |

(1) Means estimated in GLM AoV models;
(2) x, xx and xxx = F ratios for effect of milk sales within species significant at $p<0.05$, $p<0.01$ and $p<0.001$ respectively

These differences were mainly manifest in the total nutrients fed, not in the quality in terms of crude protein (increase shown, but not significant) and metabolisable energy (no increase shown).

### *5.1.4 Effect of labour availability*

In general, larger households collected more of each type of fodder than smaller households, although these associations were only significant for grazing and total fodders collected ($p<0.001$, as shown in Table 6). The practice of grazing was more common amongst larger households ($p<0.01$); 76% of the largest households (over nine members) grazed some livestock compared to only 43% of the smallest households (over four 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 6 Effect of household size on the collection of fodders***

| **Household size (number of people)** | **Total fodder collected (1)** (kg DM/day) | **Total fodder per LU (1)** (kg DM/day) | **Grazing fodder (1)** (% total) | **Fodder deficit per LU (1)** (kg DM/day) |
|---|---|---|---|---|
| (2) | 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;
(2) 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: $p=0.08$ not significant, but close to significance.

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 7), 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 7. 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 (1) | | |
| (2) | 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
(2) 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

### *5.1.5 Fodder deficits*

A high proportion of households (76%) reported deficits of some fodder, with similar proportions in all villages (Table 7). Over 90% of households reported deficits in the late dry season compared to only 21% in September. Overall, a higher proportion of households reported deficits of tree fodders than of other fodders (62% compared to 52% for cut-grass and 49% for crop residues).

***Table 8. Percentage of households reporting deficits of fodder, amounts of deficits and estimated fodder requirements in survey villages.***

| | Sig. (1) | Gajuri Chhap | Gauthale | Chan-khubesi | Tawari | Ange |
|---|---|---|---|---|---|---|
| **Households reporting deficits (%) (2)** | ns | 82 | 82 | 78 | 74 | 75 |
| **Fodder deficits (3) (kg DM/day)** | | | | | | |
| Total fodder deficit | ns | 24.2 | 25.6 | 17.5 | 20.8 | 22.2 |
| Fodder deficit per LU | ns | 3.9 | 3.7 | 4.4 | 4.5 | 5.9 |
| Deficit % of collection | - | 49 | 66 | 52 | 43 | 83 |

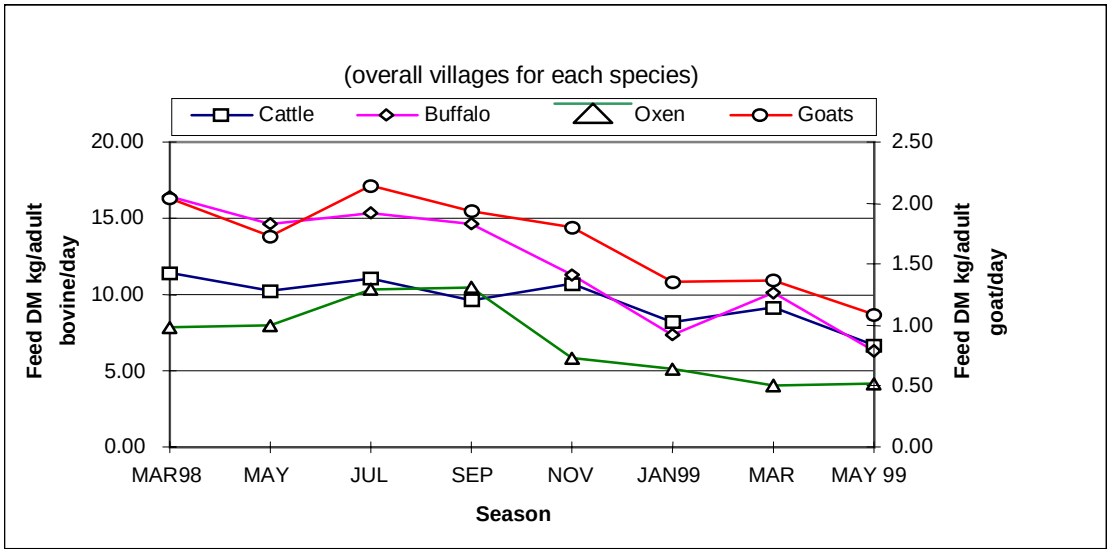
Means estimated over all seasons and other factors in GLM AoV;
(1) x, xx and xxx = F ratios for village effect significant at $p<0.05$, 0.01 and 0.001 respectively (ns = not significant)
(2) Households reporting some deficit of any fodder (converse = households never reporting deficits of any fodder
(3) Deficit amounts calculated over all households, including those not reporting deficits

Analysis of household factors associated with fodder deficits showed few consistent trends. Only the very smallest households were more likely to report deficits due to labour constraints. Households with very small livestock holdings, or the largest land holding, appeared less likely to report deficits (although this was not statistically significant). Interestingly, grazing households were more likely to report deficits than non-grazing households, despite the better nutritional value of diets, possibly because of the largest livestock holdings being associated with grazing.

Reported average deficits ranged from 43% of collections in Tawari to 83% in Ange. These were much larger than estimated deficits ranging from 3% of current collection in Gajuri Chhap to 41% in Ange(calculated by comparing households reporting deficits with those reporting none). Apparent deficits estimated in this way were largest in Ange, Chankhubesi and Gathale; a pattern that fits better with reported collection rates than the reported deficit amounts.
Fodder deficits were noted by most households in all seasons except July to September. However, in July deficits were reported by most households in Tawari, Chankhubesi and Ange, with the explanation that cut grass production did not increase sufficiently until at least one month after the start of the rains. Thus, increases in fodder supplies appear to be needed for some households in most seasons, rather than only in the late dry season; the commonly acknowledged deficit season.

Looking at changes in offer rates to different types of livestock over the seasons (Fig 3), the expected seasonal pattern of feed offer rates rising in the rainy season from July to November and falling in the dry season is evident. This is more marked for buffalo, oxen and goats than for cattle. The ability of buffalo to take greater productive advantage of high feed rates than indigenous cattle during seasons of plenty is one factor leading to the replacement of cattle in many mid-hill villages.

*Figure 3. Seasonal changes in total daily feeds offered.*




**5.2. Identification of trends in the availability of on-farm and off-farm sources of fodder, and the effect of new policies such as Community Forest Management agreements on supply of off-farm fodder and grazing resources.**

In all villages farmers reported a reduction in the availability of grazing land compared to the situation 10 years ago. In Ange and Tawari this change had been dramatic over the last three years, as access to previously-grazed community forest land had been curtailed completely. In Ange particularly this had a dramatic effect on livestock diets and, in some cases, livestock numbers. The impact was greatest for households with less private land holdings, where grazing livestock, particularly goats and cattle, had been a means of supplementing farm income that required labour, but little input from the private landholding base. Having to reduce livestock holdings in these households has led to a reduction in farm income.

Reduction in grazing practice has some positive side-effects, such as enabling children to attend school. Children may still be involved in fodder collection for animals, but this can be done before and after school hours.

All villages expressed an interest in increasing the amount of fodder cultivated on their private land, and most farmers reported already having made efforts in this direction, by the protection of wild tree seedlings. Increased cultivation on-farm called for increased vigilance and stricter social fencing of private areas so that cultivators can reap the benefits of their efforts. This requires a high degree of community cohesion and action to overcome the reluctance of certain individuals (often with the highest livestock to land holdings) to adapt their behaviour. Also, to convince those with little private land, and hence likely to gain least from the innovation, that it is for the benefit of the village as a whole. The traditional practice of free grazing on crop land after harvest is a levelling activity, potentially benefiting all equally, regardless of individual land holding. Greater privitisation of land is essential for higher productivity, but accentuates inequalities in land-holdings. The same can be said of reducing access to the community forest land for grazing. It enables more timber and fuel to be produced for one-off distribution, but restricts access by the resource-poor to collect their daily requirements of animal fodder, bedding and fallen fuel wood.

Livestock holdings were highest in the villages with most access to off-farm grazing land (Gauthale and Gajuri Chhap). Most households in these two villages kept oxen, compared to only few households in the other villages. In these villages households tended to keep a mixture of cattle and buffalo, whereas in other villages households tended to keep only cattle (Chankhubesi) or buffalo

(Tawari and Ange). Farmers in four out of the five villages reported a move to keep buffalo rather than cattle, in response to a reduction in availability of grazing land and the opportunity for milk sales. Reasons for this switch are given as increasing the potential output of milk and the butterfat content of the milk (important as this is how quality is measured at the collection points). In Chankhubesi, however, cattle are kept in preference to buffalo, with high yields being achieved by the upgrading of local breeds (majority are crossbreds of mixed grades) and a religious importance being given to the husbandry of cattle by this predominantly Hindu community.

### 5.3. Sustainable systems of fodder production to overcome constraints in supply identified.

#### *5.3.1 Towards an improved practical method of increasing production of fodder*

A practical method of stimulating the increased production of fodder resources was developed during the life of the project that involved the following five aspects:

***Village mobilisation***

To enable improved management of fodder resources, or increased cultivation of these resources, all village members need to be aware and willing to support change. Even a small number of households continuing to practice uncontrolled grazing can destroy efforts to increase fodder resources both on and off the farm. Where restrictions on community resources are being introduced, households not increasing private cultivation will experience shortages to a greater extent and will, therefore, experience more pressure to ignore new management plans. Consequently, it is of benefit to the whole village for all households to be involved and helped to be successful in fodder cultivation. This may also apply to neighbouring villages where paths and traditional grazing patterns involve animals from a wider area. Changing attitudes and behaviour are processes that households and individuals will experience in different ways and dialogue within the village is crucial for moving forward. Visits by village or household representatives to areas where new management and increased cultivation systems have been successfully developed can be instrumental in changing attitudes. Villages may find it necessary to introduce a penalty system to address the problem of some households repeatedly breaking new agreements with regard to restrictions on grazing. Within-household tensions may also need addressing, where responsibility for grazing animals and fodder collection lies with different individuals.

***Identification of current fodder needs***

Knowledge of current fodder sources, amounts available, proportions fed to different livestock and farmers production objectives for these livestock are necessary for the estimation of additional feed required. An improved practical method to achieve this is presented in Kiff *et al*., 2000 **(dissemination output 17**).

***Training***

Training at village and household levels in community forest management, nursery practices, specific species cultivation techniques, grass seed cultivation and general fodder management techniques is required. This can be done at the village site or at a training centre. Use of a training centre where participants can also visit successful community forest-user groups and on-farm cultivation sites is a particularly successful approach. Representatives may attend the off-site training centre and then conduct training for others, with the assistance of the local support NGO, on return to the village (where members are less able or willing to travel). Encouraging the involvement of women in fodder cultivation has proved successful in providing good nursery management and survival rates. The involvement of women in community forestry initiatives is also crucial, as they are usually most aware of sources and supply constraints, as the household members primarily responsible for fodder collection. While this is clearly recognised in community forestry implementation guidelines, women's active involvement in decision-making with regard to CF management is not commonly found in practice.

***Cultivation and management***

Whilst training may be given to individual household members, awareness and planning of forest management plans and on-farm cultivation needs to be shared among members of the household to ensure that the newly-planted fodder resources are protected. At farm level, the siting of new cultivation

sites needs to be planned, so as not to interfere with crop cultivation through root interactions or excessive shading.

***Monitoring performance and trials***

Monitoring of the survival and growth of different species under varying environmental conditions is very important for optimising local planting patterns and in developing and advancing the information available for training other farmer groups.

For optimising local-planting techniques, monitoring of species performance as they are distributed by households over their farm or forest is usually adequate, so long as sufficient numbers of each species are planted. Differences in survival and species growth rates in different locations become apparent over time, and farmers then adjust subsequent plantings to copy more successful previous experiences.

In order to obtain information that will be of use in other areas, a more structured approach is required to identify not only factors influencing survival and growth, but their degree of influence and possible interactions. In this case, more formalised and structured trials are required to monitor survival and growth under clearly identified conditions of altitude, aspect, soil type, fertility status, seedling density, seedling age and management practices. Details of how this was conducted on-farm is given in Amatya *et al*., 2000 (**dissemination output 21**).

### *5.3.2 Requirements to improve the quantity and quality of feeds offered*

While the amounts of feed dry matter nutrients offered generally appeared to decline in the mid-late dry season, and would require supplementation, this was not the case for all types of livestock in all villages. For example, indigenous cattle at typical local levels of production in Gajuri Chhap, Gauthale and Tawari (particularly those grazing) and indigenous buffalo in Tawari would not require much dry season supplementation. By contrast, all types of stock in Chankhubesi and Ange require additional feeds in the dry season. In situations such as in Ange, with generally low feed and nutrient offer rates, supplementation is required throughout the year.

The quality of feeds offered is low (except for goats, although degradability of the high protein tree fodder diets may be low), indicating the need for higher quality feeds to raise the level of production even within indigenous livestock breeds. This is necessary for most classes of livestock, but especially milking cows and fattening immatures, implying the substitution of some of the poorer quality crop residue feeds by those with more protein and energy. Even the improved diets of the crossbred cattle producing milk for sale (Chankhubesi) are inadequate for improved production, despite higher use of concentrates.

Seasonal differences in diet composition result in four basic types of diets being provided to animals at different times of the year, or by households in different resource circumstances. These can be described as diets based alternatively on grazing, crop residues, cut grass, or tree fodder (these being the major constituents and associated with overall diet quality). The requirements to improve the feeding of animals differs between these diet types. For example, cattle currently fed diets high in crop residues and cut grass may require high quality protein supplements (such as leguminous fodder trees and oilseed cake concentrates), whilst those on diets already high in tree fodders may require some substitution of these (and crop residues) with cut grass or stored dried grass.

Seasonal changes in the composition of diets may mean that more than one approach to improving diets is needed in individual households. Furthermore, improvements in diets are likely to require changes in the supply of more than one component (it is unlikely that changes in tree fodder availability alone will be adequate).

### *5.3.3 Potential for increasing production of green fodder off-farm*

Community management of forests has for centuries allowed substantial amounts of fodder and animal bedding to be collected, in addition to supplying timber and fuel needs for the village. Increasing population densities of people and their animals has placed increased pressure on these resources which have also suffered from changing *de jure* ownership arrangements. In some areas, heavy grazing and intensive fodder, fuel and timber collection practices have reduced previously forested land to shrub, with

poor regeneration. Whilst improved management and regeneration of such land could include production of all the afore-mentioned products (Tamrakar, 1993), in practice, handed-over community forest areas tend to be managed as one block and protected for the majority of the year, to increase production of timber and fuel resources. Thus, due to institutional, rather than biological constraints, improvement of fodder resources under community forestry programmes has not been a common practice. Current survey findings indicate that off-farm fodder sources are very important in determining both adequacy and quality of ruminant diets. For example, villages with the greatest access to off-farm sources show the best quality diets (Gauthale and Gajuri Chhap), while the worst quality diets and reduced livestock numbers occur where the community forest has recently been closed (Ange). Off-farm sources of fodder are particularly important for poorer households, with less private land holdings who are less able to compensate by private cultivation, or purchase of alternative feeds. Some improvements in fodder supply have been achieved from commonly-owned leasehold land in the mid-hills (Singh, 2000 in **dissemination output 24**) and community-owned and managed grass cultivation areas are also working successfully in India. This clearly indicates that a community-based form of ownership is not necessarily a constraint to fodder resource development.

### *5.3.4 Potential for increasing production of green fodder on-farm*

Increased cultivation of trees on farms has been a response to declining access to forest resources for over 20 years in certain areas (Carter and Gilmour, 1989). Tree densities of 600, 950 and 1,400 trees per hectare are typical of heavily tree-covered sections of rainfed land (Gilmour 1988). Even more sparsely-covered areas have densities of 150-250 trees per hectare. In some lower density areas two 2 to four fold increases in tree numbers are reported over the last 15-20 years (*ibid*, Carter and Gilmour, 1989).

Significant increases in on-farm fodder supply (particularly of fast-growing leguminous trees cultivated on terrace risers) have enabled increases in the productivity and numbers of animals kept in a few small localities (New Era, 1990). Cultivation of highly nutritious grasses has been shown to be possible in the mid-hill region, but uptake has not been widespread (Campbell *et al*. 1990 )

Fodder trees are preferred by farmers because less labour is required to harvest equivalent amounts of tree fodder than grass fodder, and tree fodder is available further into the dry season. Grasses, however, can be more palatable to larger livestock than tree fodders, are available for harvest more quickly after planting and contain less anti-nutritional factors.

There is little information available on the extent to which on-farm fodder planting can address fodder needs, or support future increases in livestock production. From the initial findings of the project, we attempt to estimate the potential increases in production of on-farm fodder at village level.

The number of seedlings of each of the different species planted in 1998 and 1999 and their survival was monitored. The figures for two years are presented separately to show different uptake rates (uptake was more rapid in Gauthale and Gajuri Chhap than other locations), and the change in species cultivated in the second year, based on farmer experiences in the first. Multiplying surviving seedling numbers by production figures, estimates of potential tree fodder production are formed (Table 9).

***Table 9. Estimate of total production (kg dry matter) of tree fodder four years after seedlings were planted in 1998 and 1999. (Adjusted for survival after one year).***

| Villages | Year | Leguminous tree fodder | | Other tree fodder | | Total tree fodder |
|---|---|---|---|---|---|---|
| | | total (kg) | per household (kg) | total (kg) | Per household (kg) | per household (kg) |
| Gajuri Chhap | 1998 | 6113.0 | 611.3 | 1530.9 | 153.1 | 764.4 |
| | 1999 | 4436.5 | 443.7 | 2775.6 | 277.6 | 721.2 |
| Gauthale | 1998 | 7540.3 | 754.0 | 980.0 | 98.0 | 852.0 |
| | 1999 | 6424.5 | 642.5 | 7612.7 | 761.3 | 1403.7 |
| Chunkhubesi | 1998 | 1641.9 | 164.2 | 2.5 | 0.3 | 164.4 |
| | 1999 | 942.3 | 94.2 | 4963.2 | 496.3 | 590.5 |
| Tawari | 1998 | 476.4 | 47.6 | 0 | 0 | 47.6 |
| | 1999 | 1925.7 | 192.6 | 5627.6 | 562.8 | 755.3 |
| Ange | 1998 | 565.0 | 56.5 | 1506.8 | 150.7 | 207.2 |
| | 1999 | 1361.1 | 136.1 | 5099.6 | 510.0 | 646.1 |

Production from grasses is very dependent on the amount of moisture available. Estimates of production under irrigated and drier rainfed conditions are given for numbers of cuttings known to be planted in 1998 and surviving in March 1999 (Table 10).

***Table 10 Estimate of production (kg dry matter) of grass fodder under irrigated and rainfed conditions from slips planted in 1998. (Adjusted for survival in March 1999).***

| Village | Grass under rainfed conditions | | Grass under irrigated conditions | |
|---|---|---|---|---|
| | total (kg) | per household (kg) | total (kg) | per household (kg) |
| Gajuri Chhap | 16.5 | 1.6 | 274.7 | 27.5 |
| Gauthale | 9.5 | 0.9 | 158.2 | 15.8 |
| Chunkhubesi | 0.0 | 0.0 | 0.0 | 0.0 |
| Tawari | 0.0 | 0.0 | 0.0 | 0.0 |
| Ange | 3.6 | 0.4 | 60.5 | 6.1 |

### *5.3.5 Perceived fodder deficits*

Whilst farmers appeared confident and clear about experiencing fodder deficits (% households reporting deficits), quantification of the deficit was found to be difficult. Consequently, deficits appear to be over estimated, when compared with amounts fed by farmers not experiencing deficits in the same season. An alternative approach to estimating deficits is to compare collection rates between households experiencing deficits, with those that are not, adjusting for livestock units. The complications this introduces into the estimates are discussed in Hendy et al., 2000 (**dissemination output 18**), and for the current broad-based estimates, farmers' perceptions of deficits are used, Table 11.

***Table 11. Mean annual deficit in total dry matter production (kg) per household, and per area of land.***

| | Gajuri Chhap | Gauthale | Chankubesi | Tawari | Ange |
|---|---|---|---|---|---|
| Crop residues | 2587.2 | 2469.6 | 1344.0 | 2721.6 | 2570.4 |
| Cut grass | 3250.8 | 2693.3 | 2173.5 | 2494.8 | 2825.6 |
| Tree fodder | 2149.9 | 2675.4 | 1258.1 | 1576.6 | 1401.4 |
| Crop residue per ropani (1) | 52.1 | 99.1 | 63.8 | 95.8 | 99.1 |
| Cut grass per ropani (2) | 114.2 | 167.7 | 160.7 | 126.0 | 191.4 |
| Tree fodder per ropani (3) | 115.5 | 245.2 | 161.6 | 128.2 | 238.1 |

(1) Ropani, total cultivated land in one year (cultivated land x cropping frequency).
(2) Ropani, total land holding (rainfed and irrigated and non-cultivated land).
(3) Ropani, area of rain-fed land only.

### *5.3.6 How far can increased on-farm fodder production meet perceived deficits?*

Comparing potential production (Tables 9 and 10) with deficit estimates (Table 11), production met between 2% (Tawari) and 20% (Gauthale) of tree fodder deficits in the first year, and in the second year between 15% (Gajuri Chhap) and 21% (Gauthale). Survival rates were particularly low in the first year at Tawari (just 10% for *Leucaena diversifolia* and 18% for *Flemingia macrophylla*) due to the very dry year and the unsuitability of these species for this frost-prone area. The use of different species (such as *Leucaena pallida*) in subsequent years will hopefully show better survival.

There is less information to date from the project on production from the grasses, as farmers have been managing their new species for seed and propagation by vegetative material. Monitoring sowing and survival of grass seed is more difficult and has only been possible so far for NB 21 *(Pennisitum purpureum* x *P americanum*) cuttings provided in the first year. Taking values from the Nepal Agricultural Research Centre hill research stations, production from these varies ten fold, according to whether they are grown under rainfed or irrigated conditions. Production varies from 0.1%(Ange) to 0.6%(Gajuri Chhap) of grass fodder deficits under rainfed conditions to approximately 2%(Ange) to 9%(Gajuri Chhap) under irrigated conditions. Future monitoring of grasses that have now come into production will provide further information.

These data indicate that even with very intensive planting activities as undertaken in Gauthale and Gajuri Chhap, it would take approximately four years of continuous planting of fodder trees at current rates to address perceived deficits. This increases to 7-9 years for sites with lower planting rates. (A certain degree of mortality after the first year is to be expected, however we know that there is some over-estimation of deficits.) Such calculations assume that households are able to cultivate the number of seedlings and cuttings that they require. Whilst some farmers experience no serious limitations to cultivation, others reported raising less seedlings than they would have liked, even in the first year of cultivation, due to land limitations. On-farm cultivation is definitely an important response to feed shortages and can be increased by suitable support. However, it has a relatively long time horizon. Furthermore, it is only able to address a proportion of shortages for farmers with smaller livestock to land ratios.

## 5.4. Fora for the discussion of findings and related work in-country between farmers and research and extension practitioners.

### *5.4.1 Farmer exchange visits and workshops*

Nepal is a strongly oral society, where a high proportion of farmers, particularly women, are non-literate. Consequently, it was planned from the outset that the main avenue for dissemination of findings would be through local-level workshops and farmers exchange visits. Some formal training was conducted during these visits (in nursery construction and management, fodder cultivation, management and use) but farmers were also able to meet and talk with other farmers who had taken up various new forms of fodder cultivation. This allowed a much wider range of topics to be addressed and farmers specific fears and concerns to be answered practically as well as theoretically. Exchange visits were conducted at the start of the project, with representatives from the five research sites visiting other sites where farmers with support from NAF had successfully cultivated large quantities of new fodders. Training was conducted during the life of the project and, as well as practical cultivation techniques, included advice on credit group development and community forestry management (though no new groups were initiated due to complicated on-going boundary disputes with neighbours). Local workshops were held towards the end of the project where adjoining communities were invited to attend, as well as all households from the community of the representative farmers. Findings from the bi-monthly surveys were fed back to farmers, growth and suitability of introduced fodder species to the locality discussed and farmers plans for further developments with regard to livestock in the area explored. Arrangements were made locally for training of interested farmers from adjoining communities in nursery production of fodders (with assistance of the local NGO) and for seed sharing by collaborating farmers with others in their community and beyond. Farmers naturally wished to plant all they could on their own land, but then showed no reticence in sharing with others. This is a part of the culture, but also of benefit in the

wider control of free grazing in the area, as some villages are on the path to water resources etc and, even though they may control grazing locally, are effected by those passing through.
Introduction of milk centres is also dependent on a minimum productive capacity in an area and so rather than a situation of competition, producers are actively encouraging others, in order to qualify for a local milk collection centre.

### *5.4.2 National-level workshop for farmers and NGO representatives*

This workshop was less well attended than the local-level workshops and training sessions. Increased political instability at the time effected attendance by two groups and the location (held centrally in Kathmandu, rather than locally in an area that they know) was intimidating for some members. The purpose was to enable sharing between farmers and NGO groups after several years of experience.
Areas of interest and discussion included quality of new fodders and the most productive ways of including them within diets; solutions to problems in cultivation of new species; modification of harvesting periods for indigenous species to meet dry season fodder requirements; and potential for ensiling materials at each site. Full details in **Report 10**, and Vickers *et al*., **2000 (dissemination output 23**).

### *5.4.3 National-level workshop for researchers, extension practitioners and policy makers.*

This workshop, held at the very end of the project, was very well attended by 65 professionals from a range of organisations. Participants including researchers from three hill agricultural stations, four universities (including one in the UK), and the Royal National Association for Science and Technology (RONAST); land/forest managers from ten District Forest Offices, representatives from leasehold, community forest management and watershed management projects; and extensionists from five international NGOs. The Secretary of the Ministry of Forests and Soil Conservation and senior members of the Department of Forests also attended. As well as the formal presentation of 14 papers by 11 organisations, lively group discussion sessions were held around themes of tools for fodder research, advances in technical knowledge of fodder management, improving feed quality, and support for developing on-farm and off-farm fodder resources. Proceedings forthcoming, DFRS (2000a) **dissemination output 24.**

## 5.5. Policy implications identified

5.5.1 Increased support for community initiatives to improve fodder resources.
5.5.2 Increased provision of milk collection points along newly opened roads.
5.5.3 Development of milk processing centres in more isolated locations with livestock development potential.
5.5.4 Pro-subsistence needs component introduced into CFM development.
5.5.5 Wider development of leasehold forestry initiatives that support resource-poor farmer development of fodder resources.

### *5.5.1 Increased support for community initiatives to improve fodder resources*

Resources in terms of fodder seeds, seedlings and cuttings and training in nursery establishment and fodder management techniques are required to support communities interested in increasing on-farm cultivation of fodders. Support connected to CFM initiation, and along the lines of leasehold forestry initiatives, are required for development of off-farm resources. Exposure visits to areas where farmers have already organised and undertaken these initiatives has proved a powerful catalyst in group development, and regular follow-up visits are found useful by some groups.

### *5.5.2 Increased provision of milk collection points along newly opened roads*

Provision of milk collection centres appears to be a key incentive in the decision of communities to reduce grazing activity, intensify in terms of stall feeding and increase production by increasing productivity per livestock unit. The resultant changes this introduced in the production system could be seen in both Chankhubesi (results after over 10 years) and Tawari (results over 2 years, as the collection centre was implemented). The changes are positive both in terms of agricultural production and environmental conservation. The traditional extensive system maximised livestock numbers, with

livestock numbers exceeding commonly-accepted carrying capacity levels over wide areas, leading to fears of resource degradation. Livestock products are crucial, however, for maintenance of soil fertility for the cropping base and to support rural livelihoods. Stall feeding, with a local outlet for milk products, appears to create the environment in which manure and income requirements can be met at the same time as concentrating livestock holdings into fewer, more productive animals.

### *5.5.3 Development of milk processing centres in more isolated locations with livestock development potential*

While centres are being introduced further into the mid-hill areas, following the road development initiatives, coverage is still far from widespread. It will be a considerable time before many areas will have sufficient access for fresh milk to be able to be successfully collected for market. There is as yet an unmet demand for both fresh and powdered milk in the main urban areas in country. Local processing of fresh milk into a powdered form has great potential. Low-technology processes have been developed and introduced successfully in a few pilot areas by foreign-supported projects. These pilot projects need to be scaled-up and introduced more widely.

### *5.5.4. Pro-subsistence needs component introduced into CFM development.*

Closure of community forestry areas to grazing and bedding collection has led to a change in feed composition and in some cases a reduction in livestock numbers. While such changes do appear to stimulate on-farm cultivation, this is not a possibility for those with very limited land holdings and will only offer a full solution to a minority; those with the largest land holdings. Furthermore, the speed with which closure occurs leaves little time for development of productive new fodder resources. While longer-term aims of the programme include re-opening of the forest for limited grazing and collection, closure for the first few years has an often irreversible effect on livestock numbers and, hence, capital for the resource poor. Possible interventions include the management of areas on a block basis, with grazing, or short-rotation coppice introduced to meet immediate subsistence needs. Support to community development of fodder resources both on-farm and off-farm.

### *5.5.5 Wider development of leasehold forestry initiatives*

Leasehold forestry initiatives have focused on meeting the needs those with less land and report success in increasing the amount of fodder available and, hence, livestock production levels among this group. A pro-subsistence needs approach would appear to be necessary within the CFM programme to prevent negative impacts on resource-poor households previously dependent on the resource for livelihoods of many kinds.

## 6. CONTRIBUTION OF OUTPUTS

### 6.1 Addressing poverty

Livestock within the integrated farming systems practised in the mid-hills of Nepal are frequently crucial to income generation. They may provide regular, small income from sales of milk, or larger amounts of income from meat sales of goats and buffalo. Livestock also provide an important means of investment and saving where transaction costs of using banks and money lenders are very high. Improving the feed of ruminants can lead to increased production, as experienced by some farmers in yield of milk obtained from buffalo regularly fed *Pennisetum purpureum* x *P. americanum* and *Pennisetum pedicellatum* (NB 21 and Dinanath). Health of the animals can also be improved (through reducing deficits experienced during the dry season), reducing the risk involved in ruminant livestock raising, and increasing returns to labour investments.

Savings and credit activities encouraged and supported within the farmers groups have been important in facilitating further livestock purchases for some members and other investment initiatives, such as preserve manufacture and marketing.

### 6.2 Contributing towards social and human development

In working predominantly with groups of women the project has assisted in increasing their own sense of worth and status in the community. This was clearly expressed by the young womens group in Tawari village when making plans for activities after completion of the research component of the project. They were all very keen on continuing to meet as a group, as well as to further develop fodder supplies and look to increase income through milk production. Keenness to continue activities was due to the positive response from families in bringing new fodder resources and ideas for increasing livestock production into the household. They were also motivated by the group providing an acceptable forum for meeting, socialising and exposure to new ideas via the local NGO facilitators. Project activities may in time lead to greater access to income by women (objective clearly expressed by the more mature women's group in Chankhubesi) who kept crossbred cattle for milk sales and knew that their improved cows were not realising their potential due to fodder shortages. This group was also interested in goat sales (a large market was quite close by), but was finding suitable fodder very hard to access. The women's group in Ange led efforts to reduce grazing in the village in order to protect newly-cultivated fodder resources. Through expanding membership of the savings group to all households in the immediate community and concerted efforts by original members and NGO staff, opinion in the village was changed so as to support controlled grazing on cultivated fields. Fines were used at one stage to discourage those not adhering to the new rules and these were paid in most cases, with support from the village development committee Chairman and the wider community.

An increase in milk production in more remote areas will also lead to a greater amount being included within the family diet. This is important for family health, particularly weaning infants, as milk products are being fed particularly to infants and the elderly.

### 6.3 Contribution to environmental sustainability and regeneration

The increased cultivation of fodders on-farm, together with an increase in stall feeding, tends to lead to fewer but more productive ruminant livestock being kept. Reduced livestock numbers will reduce pressure on environmental resources. It will also help to slow down the degradation of forest land through shrubs to pastures that occurs with open grazing at high stocking densities.

The project clearly identified the importance of off-farm sources of fodder to livestock diets, especially for those households with limited land holdings. Consequently it is important to investigate and support ways of maintaining or increasing sustainable production of fodders from off-farm sources, particularly in the light of the widespread introduction of changing management practices through the CFM programme.

### 6.4 Promotional pathways

The series of farmer training sessions, cross-visits and workshops at village level were all important dissemination and promotional pathways during the life of the project. A **Flier** was produced during the first year of the project to explain the aims of the project, planned outputs, methodology and transferability of findings (produced for researcher, secondary-level educated extensionists and an international NGO audience). A Nepali language version of this was produced as an **extension leaflet**, focusing on field-level activities and on-farm research, for local distribution (produced for local extensionists, NGOs and literate farmers). National-level workshops, one at leader farmer and supporting NGO level and one for researchers and extension practitioners were important for discussion of findings, their importance and wider relevance. Proceedings from the first national workshop can be found in **Report 10** and are in press for the second (DFRS, 2000, **dissemination output 24**). Selected papers from the this second workshop will be produced in a special edition of Banko Janakari, a national scientific journal with an established wide distribution to key research and extension organisations and departments. Within this there will be 6 papers by project staff (**dissemination products 17-22** covering all major aspects of the projects findings).

Activities and findings were documented throughout the project in a series of project reports (**Inception report** and **Reports 1-10**), which were shared with in-country, regional and DFID UK advisors, interested NGOs in-country (international and local), research centres, the Hill Agricultural Research Project and community forestry projects working in similar areas.

Collaboration with
the NAF and DFRS has ensured that findings are distributed within both the NGO and government communities. Research activities were focused within the districts in which NAF is working with member NGOs and in collaboration with the Nepal-Australia Community Resource Management project. It is envisaged that as well as farmer ownership of the research-initiatives for increasing fodder supply, NAF will be able to provide some support to on-going activities after the end of this project. However, with ever decreasing amounts of core funding, NAF are facing financial constrictions for follow-up visits and support.

**6.5 Follow-up action/ research required**

Over the three-year life of the project, survival and growth figures were obtained for the different species. However little data were available during the life of the project on their productivity. In order to be clear about potential developmental benefits of the project, more information is required on productivity from different species and management regimes. A follow-on phase is being strongly suggested by collaborators to maintain momentum of the initiative and to measure amounts of fodder now being produced from the new plantings. Specifically, the follow-on project would;

- determine the amount of additional fodder that farmers with different resource bases and livestock needs have been able to cultivate,
- determine how farmers are managing these and previously-used resources, and if their livestock feeding strategies have changed,
- monitor growth and survival in on-farm research plots, and
- determine if any dissemination of introduced techniques has occurred within the local community.

This could be combined with investigation into the spread of technologies beyond the initial contact farmers and villages, giving some indication of impact within the districts. A draft proposal for such a follow-on phase has been presented to the Programme Manager for consideration.

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## 7. DISSEMINATION PRODUCTS:

1. **Project profile**: Kiff, E. (1997). Produced in response to the request for "making the case for NR research". A one-page summary of how the project works with local NGOs and CBOs to develop with households of different resource bases, ways to increase livestock production. Includes colour graphics. [B]
2. **Inception Report**: Kiff, E. (1997). Initial visit to set-up collaborative agreements with NAF and FORESC. 19th Sept to 7th Oct 1997. Project R 6994. Inception report . Chatham: Natural Resources Institute. pp. 13. [C]
3. **Report 1**: Pandit, B.H., Hada, M. and Nakarmi, G. K. (1997). Initial Research Site Selection. November-December 1997. Project R 6994. Report 1. Chatham: Natural Resources Institute. pp. 39. [C]
4. **Report 2:** Kiff, E., Hendy, C., Neupane, R., and Basukala, R. (1998) First joint field work to characterise research sites, encourage community participation and select households for survey 8th January to 29th January 1998. Project R 6994. Report 2. Chatham: Natural Resources Institute. pp. 48. [C].
5. **Flier:** Kiff, E. (1998). Improved strategies for on-farm fodder production using participatory research techniques Project summary . English 300 copies pp2 [B].
6. **Poster** : Kiff, E. (1998). Improved strategies for on-farm fodder production using participatory research techniques. Presented at the Association for Farming Systems Research and Extension Symposium in Pretoria, The New South Africa. Copies with collaborators and Natural Resources International. [B]
7. **Report 3:** Kiff, E., Hendy C., Chhetri, R., Vickers, B. and Basukala, R. (1998). Second joint field work to cross-check bi-monthly survey findings, discuss species performance with farmers and follow-up activities and reporting with local NGOs 2nd to 12th November 1998. Project R 6994. Report 3. Chatham: Natural Resources Institute. pp. 51. [C]
8. **Extension leaflet:** Amatya, S.M., Kharel, R., Vickers, B. and Chhetri, R. (1999). DFRS and NAF collaborative research on improving fodder supply for farmers: Information leaflet. Nepali. 100 copies, pp.4 [D].
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12. **Review:** Kiff, E., Thorne, P.J., Pandit, B.H., Thomas, D. and Amatya, S. M. (1999). Livestock Production systems and the development of fodder resources for the mid-hills of Nepal. pp 67 Publisher: Natural Resources Institute, Chatham, UK. [Science] [G]
13. **Report 7** Hendy, C., Vickers, B., Chhetri, R. and Basukala, R. (2000). Interim report: Seasonal patterns of collection and allocation of fodders to livestock by households in selected mid-hill locations. Project R 6994. Report 7. Chatham: Natural Resources Institute. pp. 55. [C]
14. **Report 8** Pending (soils analysis)
15. **Report 9** Amatya, S. M. and Chhetri, R. (2000). Interim report: Survival and Growth of fodder species on experimental plots in the five research sites after six months. Project R 6994. Report 9. Natural Resources Institute. pp. 19. [C]
16. **Report 10** Vickers, B., Chhetri, R., Basukala, R., Kiff, E., Amatya, S. M., Neupane, R. (2000). Summary reports from village-level workshops and Kathmandu farmer and NGO workshop, held during March and April 2000. . Project R 6994. Report 10. Natural Resources Institute. pp. 48. [C].
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