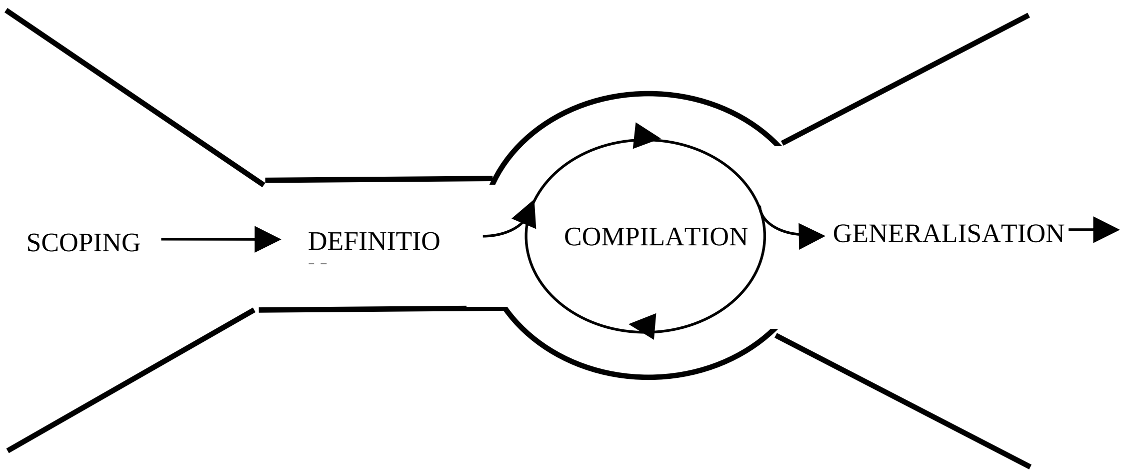
Knowledge acquisition from multiple communities



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Contents

Executive Summary

This report describes research that investigated the distribution of farmers' knowledge about tree fodder resources across the command area of Pakhribas Agricultural Centre (PAC) with the aim of developing guidelines for knowledge acquisition from multiple communities. Previously, research on indigenous knowledge had been confined to one village development committee, Solma. A rich knowledge base had been acquired through interactions with people in Solma over several years, firstly as part of project R4731 by Dr Balaram Thapa, later augmented and refined by Laxman Joshi as part of the present project (R6322).

The present research involved interviewing 220 farmers across four sites. The sites were contrasting in terms of their accessability, people's access to forest areas and market infrastructure. They were chosen to represent the range of agricultural systems within the PAC command area and thus contained differences in the reliance of the farm system on trees as a fodder resource as well as different opportunities for increasing income through trading of products. Within sites the sample of informants was further stratified according to gender and wealth (households self sufficient for food throughout the year and those who were not).

The results indicated that general classification of trees with respect to their interactive effects on crops (the *tapka*n and *malilo-rhuko* concepts) and of fodders (the *posilopan* and *ovanopan* concepts) occurred across a wide geographical area in the eastern mid-hills of Nepal. The Solma knowledge base provided an effective template for knowledge acquisition elsewhere and made the process of eliciting knowledge from new communties much faster than would have been the case had concepts and terminology had to be ascertained prior to dicussions about resource use and management at each site.

While conceptual frameworks were commonly held, detailed knowledge about particular attributes of tree species and their effects on crops and animals varied according to how important these species were to farmers at different sites. Most species occurred at most sites but their use varied according to the characteristics of the farming system. Some new knowledge was encountered in the process of exploring the relevance of the knowledge acquired from Solma at the three other contrasting sites and location had a far larger influence on what people knew (significantly different for about half of the attributes studied) than either gender (10%) or wealth (< 5%). With respect to gender, women were generally more knowledgeable than men about the detailed areas of tree-crop interactions and feeding value of tree fodder for which gender differences were significant.

The uneven distribution of knowledge amongst sites meant that new knowledge was encountered during generalisation and that there may be opportunities for sharing knowledge from some sites with people in other communities. For example, in the present study, knowledge about broom available at Mangalbare but not at the other three sites may be appropriate for dissemination.

Recommendations about knowledge acquisition were made with reference to the four stage knowledge acquisition process previously developed in project R4731 and summarised in Figure 1 on the first page of this report. These recommendations follow.

i) Initial stages of scoping and definition should be located at a site where people are heavily dependent on the resource in question, then a template useful for collecting knowledge across a broad geographical area can be developed.

ii) There is a need to stratify detailed knowledge acquisition during the compilation phase according to site. Sample sizes at each site may be relatively small (10 people) and it is clearly more important during compilation, within resource constraints, to include more sites than more people at any one location, since knowledge varies more amongst sites than within them.

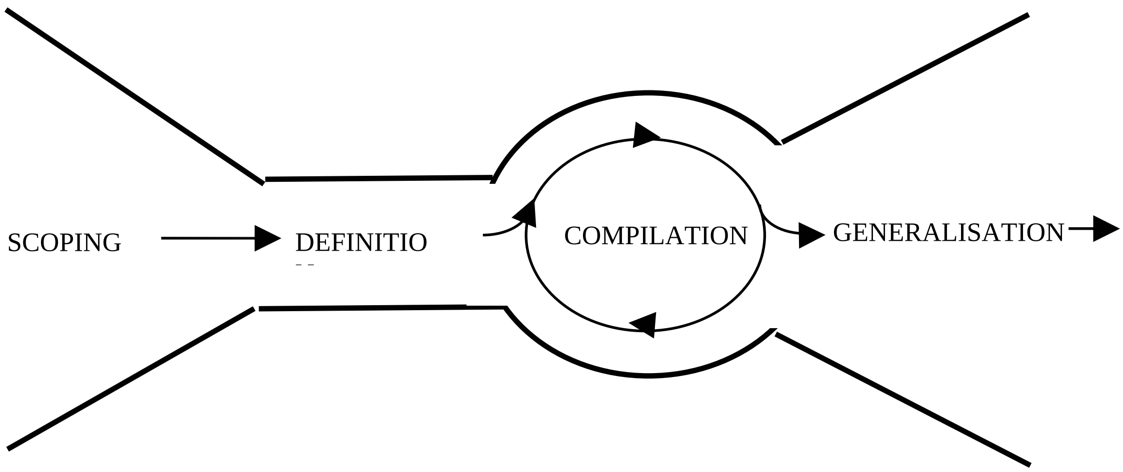
iii) The informants at each site can be selected on the basis of the researcher's perception of how much they know and are likely to articulate, since there is little evidence that more elaborate methods improve how knowledgeable the sample is. Samples at each site should include an equal number of men and women, with a gender sensitive approach to knowledge acquisition, specifically ensuring that women can articulate their views without men being present.

iv) The generalisation phase - where the distribution of knowledge is explored - requires sampling across sites reflecting the full range of resource dependence, from which opportunities for sharing knowledge amongst sites may be identified. Opportunities for augmenting the knowledge base during generalisation should be enabled.

KNOWLEDGE ACQUISITION FROM MULTIPLE COMMUNITIES

1 INTRODUCTION

It is not always possible or necessary to elicit knowledge from all possible sources when developing a comprehensive knowledge base about agroforestry (Bruce, 1989). A sampling strategy is necessary to ensure that knowledge acquisition is carried out in an efficient manner. Based on Knight's (1980) three stage methodology for investigating indigenous knowledge of agricultural practices, Walker and Sinclair (in press) proposed four stages (scoping, definition, compilation and generalisation) in the development of knowledge bases in agroforestry (Figure 1).



Objective	To refine knowledge acquisition objectives	To generate a broad understanding of domain & define boundaries & terms	To create a coherent and comprehensive knowledge base	To test how representative the knowledge base is of farmers generally
Informants and activities	A broad range of activities across the community	One or two intensive interactions with a small number of purposively selected informants	Iterative cycle: repeated interaction with stratified sample of key informants, knowledge representation and evaluation of emerging knowledge base	A variety of questionnaire-based survey approaches on a sufficiently large and randomly selected sample of informants from the community

Figure 1. The four stages of knowledge acquisition shown diagrammatically (top) with further information on each stage underneath in a tabular form. (Source: Walker and Sinclair, in press).

The most important feature of the strategy in terms of sampling was the separation of knowledge base development (the first three stages) where a small purposive sample of people were intensively involved and the generalisation stage where a large randomised sample of people were drawn from the target community to explore how representative the knowledge base was. This approach has been used in a series of investigations of indigenous agroforestry knowledge in different biophysical and cultural contexts by Thapa (1994), Jinadasa (1995), Hitinayaka (1996), Preechapanya (1996) and Kiptot (1996).

Investigation into indigenous knowledge is an arduous and time consuming exercise. Most often such studies are carried out using a small purposively selected sample or informants. Most studies of indigenous knowledge have been carried out in relatively homogenous communities and it has generally been observed that the ecological knowledge collected from small groups of key informants has broadly represented that held by people in the community from which the sample was drawn (Thapa, 1994; Jinadasa, 1995, Hitinayaka, 1996; Preechapanya, 1996). Even in a close-knit farming community in eastern Nepal, however, Thapa (1994) observed that knowledge about some tree attributes influencing ecological processes varied between farmers in relation to their experience with various tree species and Rusten and Gold (1991) reported gender differences in knowledge about tree fodder in western Nepal. Preechapanya (1996) has similarly reported variation amongst Thai farmers in their detailed knowledge about interactions between tea and forest trees.

From an institutional perspective the use of knowledge gathered from a sample of farmers in a particular community for developing research and extension programmes requires an understanding of the distribution of knowledge both within and amongst the communities concerned. In this context it is not sufficient to know merely what farmers know, but also to know what farmers do not know, and more specifically which farmers do not know particular knowledge items, as this is crucial information for making decisions about requirements for extension of existing knowledge as opposed to the generation of new knowledge through the research process.

Nepalese hill farming systems are characterised by diverse and heterogeneous bio-physical as well as socio-cultural situations (Gibbon and Schultz, 1992). Given the heterogeneity that normally exists within and between different categories of people (such as wealth and gender groupings) within a community, differences in the knowledge held by these different farmer categories can be expected.

In a knowledge acquisition study, the purposively selected key informants are, by definition, perceived by the researcher as being the people most knowledgeable about the domain in the community. However, in Rwanda den Biggelaar and Gold (1995) compared what their purposive sample knew with randomly selected informants and found that the key informants were not necessarily the most knowledgeable and that criteria used to gauge how much people knew, both by the researcher himself and people from the community asked to identify knowledgeable people, were often culturally bound and related to people's status rather than experience or knowledge. Clearly how knowledgeable the selected key informants are has major implications for the overall knowledge acquisition strategy and the utility of knowledge bases thus developed.

Previous studies on indigenous knowledge have focused on testing the degree of representativeness of knowledge collected from a small number of key informants among other members of the same community by stratified random sampling. The present study aims to consider a wider institutional remit involving multiple communities. This requires exploration of the distribution of knowledge about tree fodder across a wider geographical area than has previously been attempted and assessing knowledge collected from one community against what is known by people in other communities. This involves considering several communities with differences between communities as well as within them. The results of this exploration can then be used to devise effective knowledge acquisition strategies for such situations.

In the context of existing heterogeneity within and amongst multiple communities and the articulation of knowledge from predetermined "experts" in a community, the knowledge acquisition strategy will be influenced by two factors :

1. the distribution of knowledge amongst groups of people, with similar resources and interests, that are used to stratify sampling; and
2. the knowledgeability of the key informants in relation to their fellow colleagues within each grouping, hence their appropriateness as informants for such investigation.

With the overall goal of determining an effective knowledge acquisition strategy from multiple communities, the objectives of the current study were :

1. to explore the distribution of knowledge about tree fodder resources across different sites and different groups within each site (wealth status and gender); and
2. to determine the differences in knowledge held by purposively selected key informants and other farmers.

It was envisaged that in achieving these objectives the dialogue with the farming communities involved could be used to clarify and augment the knowledge base on tree fodder resource management previously developed by talking to people in a single VDC[1].

2 KNOWLEDGE DISTRIBUTION IN MULTIPLE COMMUNITIES

2.1 Introduction

Knowledge distribution in the present context can be defined as the extent to which knowledge about tree fodder resource management is shared by the client farmers both within and amongst multiple communities across the eastern hills of Nepal.

Thapa (1994) tested the representativeness of a subset of the knowledge articulated by key informants in Solma VDC among other farmers in the same community. He concluded that knowledge of various tree attributes varied among farmers in a community in relation to which tree species the farmers had experience of cultivating. This finding

[1] Village Development Committee - the basic administrative unit

has been used as a basis for proposing the hypothesis that the extent and type of knowledge a farmer holds about attributes of tree species will depend on the location, gender and socio-economic category of the farming household, each of which is discussed below.

Location

Nepalese hills are characterised by steep topography and as a result climate and vegetation vary significantly over short distances. It can, therefore, be expected that farmers in one community may have more knowledge about the tree species relevant to the conditions pertaining on their surrounding land than other species which are absent or less common in the area.

Gender

The roles and responsibilities of male and female members of a farming household in Nepalese hill farming culture are distinct and gender division of labour is common (Saul, 1992). Rusten (1989) reports that there are significant differences in the preferences for tree fodder species between men and women in the western hills of Nepal. Although women in rural Nepal are involved in farming and are active in decision making (Molnar, 1992; Rusten, 1989; Robinson, 1990), men do most of the tree planting and make decisions about which species are planted and where to plant them (Thapa, 1994). With regard to tree fodder resource management, it is primarily the men who lop trees and women and children who collect and carry fodder and feed it to animals. Thapa (1994) did not report differences in ecological knowledge about trees according to gender but neither did he distinguish between men and women in the knowledge acquisition process. Gender sensitivity, using female interviewers and sessions where women can talk without men present, may be important in knowledge acquisition in Nepal because of cultural inhibitions felt by women in mixed gender situations. It is, therefore, reasonable to assume that there may be differences in knowledge according to gender and that these may only be revealed by using a gender sensitive knowledge acquisition strategy.

Socio-economic status

Wealth confers different access to forests resources. The resource-poor normally have smaller land holdings and less private tree resources at their disposal than wealthier farmers. Southern (1994) found that the number of tree species per hectare decreased exponentially with increasing garden size in Kandy, Sri Lanka. Similarly, in Solma VDC, Nepal Thapa (1994) observed that while the total number of fodder trees per farm increased with farm size the tree density per unit area decreased with increasing farm size. In Rwanda den Biggelaar (1995) also found that with a decrease in farm size, reflecting the resources of farmers, there was an increased intensity of tree and crop integration. He further observed that the extent of indigenous agroforestry knowledge was related to farmers' experience of integrating trees and crops and was, therefore, richer amongst farmers with smaller land holdings.

These observations indicate that resource-poor farmers, with smaller land holdings, may

- integrate trees and crops more than wealthier farmers;
- have greater species diversity per unit land area; and, therefore

- know more about interactions amongst species.

2.2 Methodology

2.2.1 Topic selection

The Solma farmers' knowledge base on tree fodder resources at PAC contains a large amount of ecological knowledge from farmers and it is neither practical nor necessary to test the distribution of all of this knowledge to learn about knowledge distribution generally. It was noted by Thapa (1994) that in Solma an individual farmer's knowledge about specific species was limited to the species with which the farmer was acquainted. He also noted that although knowledge about general interactive processes (such as *tapkan*[2]) tended to be commonly held, not all attributes influencing such processes were widely known by the members of the farming community because some attributes were specific to uncommon tree species.

Farmers' qualitative knowledge about individual species tends to be comparative in nature and may, therefore, depend not only on the attributes of a particular species but also upon other species it can be compared to. It has already been observed that a single species may be classified differently by different farmers. From an ecological perspective it is the criteria used by farmers to classify species which are more important than their actual placement of species in a classified hierarchy. Coupled with the fact that different farmers cultivate different species, it was not practicable to evaluate the distribution of species-specific knowledge. However, the species with which individual farmers were acquainted were used as a basis for discussing the ecological processes involved in managing tree fodder resources on farm land.

The Solma tree fodder knowledge base contains statements primarily about two major topics. Firstly, effects of trees on crops and secondly, the attributes of tree fodder that influence its feeding value. Understandably, these are the two major aspects upon which farmers base their day to day decisions about tree fodder resource management. The following subsets of knowledge were, therefore, selected from these two general topics to ensure coverage of the types of knowledge held within the knowledge base.

1. *Tapkan* and its effects on crops.
2. The *rukho-malilo*[3] concept and its impact on adjoining crops.
3. Fodder quality and its implications on large ruminant productivity.
4. Palatability of tree fodder.
5. Implications of *posilopan*[4] and *ovanopan*[5] status of tree fodder on large ruminants.

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[2] Nepali word for water droplets falling from tree leaves that cause splash erosion of soil
[3] Nepali words for trees that have negative (rukho) and positive (malilo) effects on associated crops and soil
[4] Nepali farmers' system for classifying the nutritional value of tree fodder (found to correspond to protein supply to the duodenum in ruminants)
[5] Nepali farmers' system for classifying fodders as 'dry and warm' or 'cold and wet' (found to correspond to overall dry matter digestibility of fodder and important with respect to how fodders satisfy appetite and the consistency of animal dung, which is important in a system where dung is manually collected for use as fertilizer)

Two sets of questionnaires were prepared in Nepali, one for collecting basic information about interviewees and a second questionnaire for testing knowledge distribution. Both questionnaires were pre-tested and modified as necessary to ensure they served their intended purpose.

2.2.2 Site selection

Three sites (Mangalbare in Ilam district, Rajarani in Dhankuta district and Pokhari[6] in Sankhuwasabha district) were selected for the knowledge distribution testing. The selections were made on the basis of the following criteria.

1. To encompass, in the whole sample, sites with different access to government or community forests thereby influencing the dependency people have on private trees (Gilmour, 1990). Mangalbare has ample privately managed forests with little government or community forests; while Pokhari still has natural forests in its vicinity. Rajarani and Solma fall somewhere in between.
2. Differential remoteness of the sites. Mangalbare is accessible by a motorable road almost throughout the year and has a well developed market infrastructure; Rajarani has been only recently joined by a road; and Pokhari is still remote with two days walk from the nearest motorable road.
3. The sites are well distributed from east to west of PAC's current command area.
4. All sites at the time of study were PAC outreach research sites[7] and were considered representative of their district (Joshi *et al.*, 1990; PAC, 1990). This also ensured that PAC already had a good rapport with the local people in the sites and possessed secondary information (a household list and farmer categorisation according to wealth ranking and information on land use and farming practices).
5. No forestry extension activities had been previously carried out by PAC at the sites.

2.2.3 Farmer selection

Based on the fact that most tree cultivation on farmland is confined to the mid altitude zone of approximately 1000 m to 2000 m range where *bari*[8] land predominates, the knowledge distribution study was limited to those households residing within this range. At higher altitudes, pasture land and natural forests predominate while at lower altitudes, *khet*[9] land becomes more prominent on which trees are rarely retained (Thapa, 1989).

Lists of farm households living in each ward were compiled from the information available at VDC offices. The names on each list were verified by visiting the ward and consulting a group of farmers who new their ward colleagues well. During the visit, a date and site for conducting a wealth ranking exercise (Grandin, 1988; Joshi *et. al.*, 1993) and the people (four to eight) in the area to invite for the exercise were chosen. These informants were informed in advance. The names on the list were written on cards and on the fixed date, informants were asked to first verify the names and then categorise the households based on their understanding of the food sufficiency criterion developed at

[6] Pokhari is the commonly used abbreviation for Siddhapokhari.
[7] In July 1996, new outreach research sites were selected to replace most of the previous sites.
[8] Refers to upper-slope rain-fed cultivated land
[9] Refers to irrigated land on lower slopes

PAC (Joshi and Rai., 1993). The criteria farmers used when categorising on their own perception of wealth included land holding, animal number, house size, off-farm employment (retailing, portering), additional income (pension, land tenancy), and ability to lend money to others.

Upon completion of the wealth ranking exercise, the names of farming households from all wards falling within a category were compiled. For the purpose of stratification of the farming households, farmers with surplus production (A category) and those with just sufficient production (B category) were combined to form a food sufficient group. Likewise, the C category farming households (food sufficient for less than twelve but more than six months) and the D category (food sufficient for six months or less) were pooled to form a food insufficient group. Thirty farm households were randomly selected from the food sufficient group and thirty from the food insufficient group. The thirty farm households were further subdivided into two equal groups according to which gender was to be sampled - a male group and a female group. The final list of sample households at each site thus comprised sixty names grouped into two economic classes based on food sufficiency of the household which were further sub-divided into a male group and a female group. Due to unrest at the site, only 40 of the 60 selected farmers could be interviewed in Mangalbare so that altogether 220 farmers were interviewed across four sites.

Individual sample households were visited and the availability of an appropriate interviewee (male or female depending on the gender group that the household fell into) and his/her willingness to participate was confirmed. Only farmers who were actively involved in farming and thus contributed to household decisions about tree fodder were regarded suitable for interview. On a number of occasions, alternative candidates had to be selected due to absence or physical disability of a person of the required gender in the selected household. During the visit, background information about the interviewee and the household was also collected. The whole exercise took less than half an hour and helped build rapport and confidence between the interviewee and interviewer. A date and time for the main interview was fixed.

Male interviewees were interviewed by a male interviewer while female interviewees were interviewed by a female interviewer. This was felt necessary as in some ethnic groups and households, it was observed that female interviewees were reluctant to speak openly in front of the men. The second phase of the interview was on average one hour which is considered a limit for such interviews.

2.3 Background information about study sites

The following section briefly outlines the bio-physical and the socio-economic information about the four research sites and the interviewee farmers. Background information about the study areas was obtained from secondary sources. Information about the interviewee and the household was collected in a questionnaire interview conducted when the household was first visited.

A brief description of each research site is presented below. Details about farmers' land and livestock holding, fodder trees and tree fodder situation, compiled from individual farmer interviews, are presented for all sites together in the sections that follow (Sections 2.4.1 - 2.4.4).

2.3.1 Solma

Solma VDC lies in Terathum district in Koshi Zone and is situated on a long south and south-east facing slope with an elevation ranging from 500 m to 3000 m. Of the total 2229 ha, half is cultivated for agriculture (Stewart, 1987). Human settlement is mostly concentrated between 1000 m and 2000 m. At higher altitude grassland (locally known as *nagi*) primarily used for grazing animals is predominant. Most of the remaining natural forest is also present at higher altitudes and mainly composed of *Rhododendron* and *Quercus* species. At altitudes below 1000 m, *Pinus roxburghii* and *Shorea robusta* predominates in small patches of forests.

The major economic activity in Solma is agriculture mostly of a subsistence nature. Nearly 50 per cent farmers own less than a hectare of land (Thapa, 1994). By hill standards, Solma can be considered to have reasonable access to markets at Myaglung (Terathum district headquarter) and Basantapur (the terminal point of the nearest motorable road). A rough seasonal road from Basantapur to Myaglung which runs along the Solma border in the north (high altitude) is under construction. Despite the potential for growing cash crops and other commodities, little trading exists apart from collection of some fruits (mandarin and guava) from lower altitudes.

2.3.2 Mangalbare

Located in the eastern border district of Ilam, Mangalbare VDC has a southern aspect and extends from 1 090 m on river beds in the south to 2 000 m on hill tops. The VDC covers an area of 2 750 ha of which about 67 % is cultivated while 16 % is covered by forest; the remaining land being occupied by grassland and shrubs (Stewart, 1987). Although the area is well covered with natural vegetation, most of the forests belong to individual farmers. Except for the community forest in ward 8 which is used by only a few households living in the vicinity of the forest, there is virtually no government forest in the area.

Although the total population of Mangalbare VDC is reported to be 4 969 (PAC, unpublished), the high mobility of shopkeepers and traders in the VDC makes the population figure dynamic. The primary ethnic groups living in the VDC are Brahmin, Chhetri, Newar, Rai, Limbu and Sunwar while fewer households consist of Tamang, Sherpa, Damai and Kami people.

The primary occupation of farmers is agriculture; many households of ward number 1, which is the trading centre of the VDC, are also engaged in business. Many farmers have *khet* land in the Terai. Maize and paddy are the principal cereals grown in the area. In recent years farmers have started growing winter crops such as wheat, mustard, potato and vegetables. Tea, cardamom (*Amomum subulatum*) and broom grass (*Thysanolaena maxima*) are now grown by a majority of households. In the past these crops were only grown on uncultivated land. The value of cash crops, particularly cardamom and broom grass has risen significantly in the last few years. Cultivation of cardamom and broom grass is not labour intensive and requires a relatively small investment of time and effort for a high monetary return compared to staple crops. As a result many farmers have converted their *khet* land and *bari* land to *alainchi* (cardamom) *bari* and *amliso* (broom grass) *bari* lands.

Livestock keeping, particularly dairy cattle and buffalo, is a profitable enterprise in Mangalbare as there is a good market and the necessary infrastructure (milk chilling and collection centres) nearby. Improved breeds of large ruminants such as Jersey cattle and Murra buffalo were brought from India through the eastern border a few decades ago. These animals have adapted well to the local conditions and farmers now consider the breeds as local.

There is a rough motorable road to ward 1 in Mangalbare although during the monsoon season the road is normally unusable. Access to and the transportation system within most VDCs in the eastern districts are better than in VDCs in other regions. There is a good market channel for agricultural products to be taken out of Mangalbare and the living standards in the area have been improved by consequent commercial activities in the VDC.

2.3.3 Rajarani

Rajarani is the southern most VDC of Dhankuta district and adjoins Morang district in the Terai. It is a relatively small VDC covering only 1541 ha of which 51 per cent is agricultural land (Stewart, 1987). There are 467 households mostly of Limbu, Rai and Brahmin ethnicity. Agriculture is the chief occupation and many farmers have agricultural land in the Terai. Many households have at least one family member in a foreign country earning money for the household. For these families, the external income is far greater than the income from agriculture. Out migration to the Terai and Kathmandu is widespread and farmers in the area said that the number of residents in the VDC had not increased over the last two.

There is still ample natural forest left in the vicinity; and although quite degraded, these forest areas have been handed over to local people as community forests in recent years.

There is now a recently constructed dry season motorable road to Rajarani. Agriculture in the VDC is almost static in a sense that not much has changed for a long time. Production in the VDC is not sufficient to meet the demand of its population and a substantial amount of rice is imported from the Terai.

2.3.4 Pokhari

Pokhari lies in Sankhuwasabha which is considered a remote district. The nearest motorable road is a two-day walk from the VDC. The total number of households is 596. Agriculture is the major occupation but cardamom is the choice crop grown wherever possible. Many households sell cardamom and purchase rice and other food grains from lower altitudes for family consumption.

The VDC covers an area of 4 045 ha of which over 2 300 ha is forest land (Stewart, 1987). Large tracts of land are occupied by forests particularly at higher altitudes. The increase in cardamom cultivation has dramatically increased the area under tree cover in the last three decades.

Pokhari is largely a remote VDC and the nearest motorable road about two days walk from the district headquarter. The remote wards 1 and 2 are mainly under forest cover and are very sparsely populated. There are visual signs of recent encroachments into the forest land for cultivation. The number of trees, particularly of forest origin, on cultivated land is relatively high.

2.4 Basic information about farmers

2.4.1 Farmer categories and land holding

The farmer categorisation exercise among farmers in each field site living in the 1000 m to 2000 m altitudinal range indicated higher proportions of farmers falling in the B, C and D wealth categories in Mangalbare, Rajarani and Pokhari (Figure 2). A slightly different distribution was observed in Solma where the number of category A farmers was much higher than the other three sites. However, Thapa (1994) observed a slightly different distribution in Solma with category B and C farmers outnumbering category A farmers. In the present study only six of the nine wards and about 60 per cent households (living within 1000 m to 2000 m altitudinal range) were studied while Thapa conducted his wealth ranking exercise in all nine wards including 578 households. In all the sites, the proportion of food insufficient (C+D categories) farmers was higher than that of the food sufficient (A+B categories) farmers.

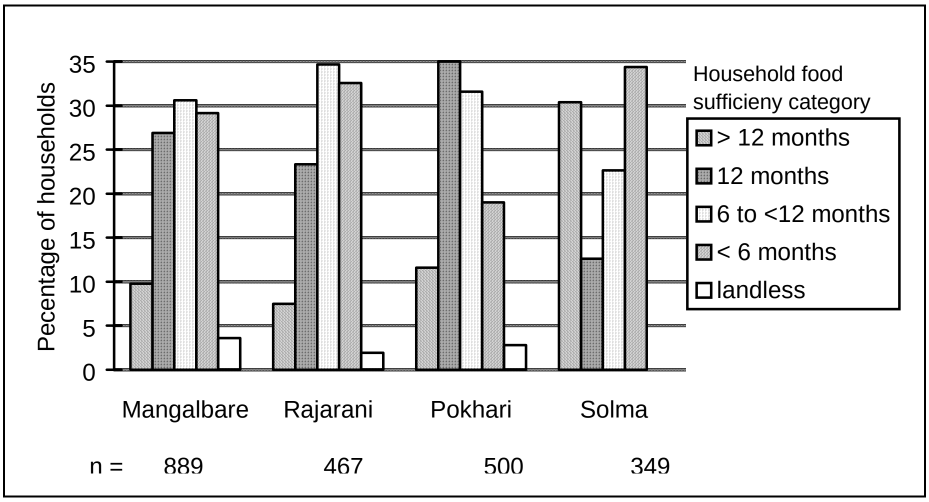

Figure 2. Farmer food sufficiency categories in research sites.

The major economic activity in all four study areas was agriculture but the dependency of the farming households on agricultural activity varied amongst sites and also between farmer categories (Table 1). All farmers had *bari* land and the majority of farmers also had *khet* land, although the proportion owning *khet* land varied amongst sites from as low as 62 % in Rajarani to 83 % in Solma. As expected the size of land holding of food sufficient farmers was significantly higher than the food insufficient farmers. Food sufficient farmers had more than twice the *khet* area (1.2 ha) of the food insufficient farmers (0.5 ha), and the proportion of farmers owning *khet* land was also nearly 50 % higher for the food sufficient farmers. Farmers in Mangalbare had the largest area of *bari* land (0.8 ha) and farmers in Solma the smallest (0.5 ha).

Table 1. Mean land holding (ha) distribution with site and economic category. Figures in brackets indicate percentage of farmers owning land type.

Farmer category	Land type	Mangalbare	Pokhari	Rajarani	Solma	Total
Food sufficient	*Bari* land	0.9 (100)	0.8 (100)	0.8 (100)	0.6 (100)	0.8 (100)
	Khet land	0.9 (84)	1.5 (90)	0.9 (83)	1.5 (97)	1.2 (89)
	Nagi	0.5 (5)	- (0)	0.5 (7)	0.3 (10)	0.4 (6)
	Alainchi bari	0.5 (74)	1.1 (70)	0.1 (10)	0.2 (31)	0.7 (44)
	Chia bari	0.1 (16)	- (0)	0.2 (3)	0.8 (3)	0.2 (5)
	Kharka	- (0)	- (0)	0.2 (3)	- (0)	0.2 (1)
	Kharbari	0.1 (26)	0.1 (10)	0.2 (33)	0.2 (14)	0.2 (20)
	Private forest	1.0 (16)	1.0 (7)	0.2 (7)	0.6 (3)	0.8 (7)
	Pakha bari	- (0)	- (0)	- (0)	- (0)	- (0)
	Amliso bari	0.2 (42)	- (0)	0.1 (10)	- (0)	0.1 (10)
Food insufficient	*Bari* land	0.6 (100)	0.3 (97)	0.6 (100)	0.3 (100)	0.5 (99)
	Khet land	0.5 (57)	0.6 (70)	0.4 (40)	0.4 (71)	0.5 (60)
	Nagi	0.9 (14)	0.2 (3)	0.2 (7)	0.6 (10)	0.6 (8)
	Alainchi bari	0.2 (71)	0.3 (80)	- (0)	0.1 (19)	0.3 (40)
	Chia bari	- (0)	- (0)	- (0)	- (0)	- (0)
	Kharka	- (0)	- (0)	0.4 (3)	0.1 (3)	0.3 (2)
	Kharbari	0.2 (57)	0.1 (7)	0.2 (50)	0.1 (3)	0.2 (27)
	Private forest	0.4 (19)	- (0)	0.1 (10)	- (0)	0.2 (6)
	Pakha bari	- (0)	0.3 (3)	- (0)	- (0)	0.3 (1)
	Amliso bari	0.2 (52)	- (0)	0.2 (7)	- (0)	0.2 (12)
Overall	*Bari* land	0.8 (100)	0.6 (98)	0.7 (100)	0.5 (100)	0.6 (100)
	Khet land	0.7 (70)	1.1 (80)	0.7 (62)	1.0 (83)	0.9 (74)
	Nagi	0.8 (10)	0.2 (2)	0.3 (7)	0.4 (10)	0.5 (7)
	Alainchi bari	0.3 (73)	0.7 (75)	0.1 (5)	0.2 (25)	0.5 (42)
	Chia bari	0.1 (8)	- (0)	0.2 (2)	0.8 (2)	0.2 (2)
	Kharka	- (0)	- (0)	0.3 (3)	0.1 (2)	0.2 (1)
	Kharbari	0.2 (43)	0.1 (8)	0.2 (42)	0.2 (8)	0.2 (24)
	Private forest	0.6 (18)	1.0 (3)	0.2 (8)	0.6 (2)	0.5 (7)
	Pakha bari	- (0)	0.3 (2)	- (0)	- (0)	0.3 (0)
	Amliso bari	0.2 (48)	- (0)	0.1 (8)	- (0)	0.2 (11)

A notable difference was observed in the proportion of farmers growing cardamom and broom. The majority of farmers in Mangalbare and Pokhari (>70%) grew cardamom whereas less than half of the farmers in Rajarani and Solma did so. The mean area of cultivated cardamom, for farmers in Pokhari who did grow it, was more than double that of the Mangalbare farmers who cultivated it. Similarly, food sufficient farmers had a larger area of cardamom than the food insufficient farmers. Nearly half of Mangalbare farmers grew broom with a mean area of 0.2 ha whereas no farmers in Solma or Pokhari set aside any land for broom.

2.4.2 Livestock holding

Almost every household had cattle with an average of around four animals per household. Most farmers also kept goats. Pigs were reared by most Rai and Limbu households. Both cattle and buffalo numbers per household were highest in Pokhari although a higher proportion of farmers (70 %) in Mangalbare kept buffalo compared to other VDCs (Table 2). Likewise, more farmers in Rajarani and Pokhari kept pigs than farmers in Mangalbare and Solma. This is explained by the fact that there are more Rai, Limbu and Sherpa households (who consume pork) in Pokhari and Rajarani compared to Mangalbare and Solma. Due to cultural traditions only the Rai, Limbu and Sherpa households kept pigs while other ethnic groups rarely did so (Gurung *et. al.*, 1989).

Table 2. Mean numbers of different classes of livestock for households at different sites and within different economic categories. Numbers in brackets are the percentage of households with that type of livestock (means were calculated using the number of households owning each type of livestock)

Farmer category	Animal	Mangalbare	Pokhari	Rajarani	Solma	Total
Food sufficient	Cattle	4.0 (100)	5.4 (97)	4.9 (100)	3.9 (100)	4.6 (99)
	Buffalo	2.3 (79)	2.5 (47)	2.0 (20)	2.4 (66)	2.4 (50)
	Sheep	2.0 (5)	5.3 (10)	2.5 (7)	9.0 (3)	4.6 (6)
	Goat	4.1 (74)	6.3 (93)	6.5 (93)	7.0 (83)	6.2 (87)
	Pig	1.7 (32)	1.7 (67)	2.0 (90)	1.9 (24)	1.9 (56)
	Rabbit	1.5 (10)	11.5 (7)	2.0 (3)	8.5 (6)	6.4 (6)
Food insufficient	Cattle	3.9 (95)	3.6 (97)	3.2 (83)	3.1 (100)	3.4 (94)
	Buffalo	1.6 (62)	2.3 (23)	1.3 (23)	1.5 (19)	1.7 (29)
	Sheep	1.0 (5)	5.0 (13)	4.0 (3)	3.2 (19)	3.7 (11)
	Goat	3.9 (67)	4.8 (93)	4.1 (80)	3.4 (81)	4.1 (81)
	Pig	1.1 (18)	1.7 (45)	1.2 (43)	1.9 (28)	1.5 (35)
	Rabbit	2.0 (3)	NA (0)	1.0 (2)	3.0 (2)	2.0 (1)
Overall	Cattle	3.9 (98)	4.5 (97)	4.1 (92)	3.5 (100)	4.0 (96)
	Buffalo	2.0 (70)	2.4 (35)	1.6 (22)	2.2 (42)	2.1 (40)
	Sheep	1.5 (5)	5.1 (12)	3.0 (5)	4.0 (12)	4.0 (9)
	Goat	4.0 (70)	5.6 (93)	5.4 (87)	5.2 (82)	5.2 (84)
	Pig	1.4 (33)	1.7 (78)	1.6 (88)	1.9 (40)	1.7 (62)
	Rabbit	1.7 (8)	11.5 (3)	1.5 (3)	6.7 (5)	5.1 (5)

The mean livestock holding per household for cattle, buffalo, sheep, goats and pigs was significantly higher among the food sufficient farmers compared to the food insufficient farmers. The proportion of farmers keeping animals, except for sheep, was also higher among the food sufficient group.

2.4.3 Fodder trees[10]

Basic information about which fodder tree species and how many of each, as reported by interviewees, was recorded. Only those trees which had been deliberately retained were included. A total of 98 species were reported to have fodder value by farmers from the four sites. From a previous tree inventory carried out in Solma, Thapa (1994) reported 129 species of which 90 species were considered to have fodder value. Although the majority of the common species were found in all four sites, there were a few which were site specific. *Fraxinus floribunda* and Dhukur bans (botanical name unknown) were reported from Rajarani only; *Chamlayo* (botanical name unknown) from Rajarani and Solma; *Ficus bengalensis* from Mangalbare and Rajarani; while *Brassiopsis hainla* which was considered a good fodder for goats was not reported from Rajarani.

Table 3. Number of privately owned trees per household.

Farmer category	Tree type*	Mangalbare	Pokhari	Rajarani	Solma
Food sufficient	Mature fodder trees	164	53	43	53
	Young fodder trees	124	46	23	40
	Other mature trees	5	25	5	4
	Other young trees	4	38	5	1
	Mature *Thysanolaena maxima*	2258	2	154	NA
	Young *Thysanolaena maxima*	526	2	5	NA
Food insufficient	Mature fodder trees	75	33	34	33
	Young fodder trees	91	23	23	30
	Other mature trees	4	29	3	2
	Other young trees	3	20	2	1
	Mature *Thysanolaena maxima*	1353	3	83	NA
	Young *Thysanolaena maxima*	143	1	0	NA
Overall	Mature fodder trees	119	43	39	43
	Young fodder trees	107	34	23	35
	Other mature trees	4	27	4	3
	Other young trees	4	29	3	1
	Mature *Thysanolaena maxima*	1794	3	119	NA
	Young *Thysanolaena maxima*	330	2	3	NA

* Trees which were currently under production or harvest were considered mature and young trees were those which were deliberately retained but had not reached harvest stage.

The number of trees (fodder and non-fodder) per household is presented in Table 3. The total count includes trees from all private sources (*bari* land and private forests). Fodder

[10] "Tree" refers in this report to a literal translation of *rukh* in Nepali and this includes all woody perennials including bamboos and shrubs.

species are those which many farmers retained primarily for fodder. The number of trees per household in Mangalbare is almost triple that for other sites and the trees are primarily concentrated in private forests including *alainchi bari*. Again the number of broom plants was far higher in Mangalbare than in other sites.

Ficus neriifolia, Bambusa nutans, Prunus cerasoides, Dendrocalamus hamiltonii, Saurauia napaulensis, Schima wallichii, Ficus semicordata var. semicordata, *Ficus auriculata, Ficus lacor, Litsea monopetala* and *Albizia julibrissin* were cultivated by over 50 % of farmers. These trees constituted over 60% of the total tree population. These dominant species are also dominant in other parts of Nepal (Rusten, 1989; Carter, 1991). Only *Schima wallichii* had little fodder value. *Alnus nepalensis*, an ubiquitous species in the eastern hills, constituting major proportions of private forests and *alainchi bari*, has not been included as most farmers did not consider it to have any fodder significance. The fodder value of the reported species was observed to vary not only between research VDCs but also amongst individuals in a single VDC. Only those species considered to have a significant importance in providing tree fodder were noted. There were 48 such species. The total number of tree species in each site varied from 45 to 59 of which from 35 to 45 were valuable for fodder.

Ficus neriifolia was by far the most common fodder species (17 per cent of all cultivated trees) with 90 per cent of farmers cultivating the species. This is perhaps because it regenerates prolifically and provides high quality fodder throughout most of the dry season. The density of *Ficus neriifolia* was lowest in Mangalbare but this was compensated by a higher density of *Saurauia napaulensis* and bamboos.

2.4.4 Tree fodder[11]

There were four primary sources of tree fodder. Overall figures indicate that only as little as 4 % of tree fodder, particularly for the resource poor farmers, came from community/government forests while nearly 80% was met from trees on cultivated land (Table 4). The contribution to total tree fodder from cultivated land in Solma and Pokhari was over 90% while in Mangalbare only about a third of the tree fodder came from cultivated land while *amliso bari* and private forest (including *alainchi bari*) accounted for a large proportion of the supply. Breakdown of tree fodder sources amongst farmer categories indicates that the food sufficient farmers extract a slightly lower proportion of tree fodder from cultivated land than the food insufficient farmers. In Mangalbare, the food insufficient farmers received a significantly higher proportion (45%) of fodder from broom than food sufficient farmers.

[11] Tree fodder is used in this thesis as a synonym of the Nepali term “dale ghans” and both terms are used interchangeably. It includes fodder from trees, bamboos and shrubs as well as broom grass (*Thysanolaena maxima*).

Table 4. Tree fodder contribution (%) from different sources.

Fodder source	Mangalbare	Pokhari	Rajarani	Solma
Trees on cultivated land	31	90	84	96
Thysanolaena maxima	39	2	4	0
Private/alainchi forest	30	4	3	1
Community forest	0	3	9	3
Other sources	0	0	1	0

Farm animals in Mangalbare received over 1 400 kg fresh mass[12] per livestock unit (LSU)[13] of tree fodder, more than double that at any other site. Animals in Solma received the lowest quantity of tree fodder (Table 5). This is consistent with households in Mangalbare having more than twice as many fodder trees as households at other sites (Table 3). It is interesting and rather surprising to note that the total amount of tree fodder available among the food insufficient farmers in all sites was higher than that for the food sufficient farmers. This is perhaps a reflection of the higher dependency of resource-poor farmers on tree fodder for feeding their livestock compared to the wealthier farmers who have higher quantities of crop by-products and other animal feed sources available to them.

Table 5. Tree fodder available per LSU (kg fresh mass)

Farmer category	Mangalbare	Pokhari	Rajarani	Solma
Food sufficient	1206	681	492	384
Food insufficient	1647	753	651	396
Mean for site	1437	717	573	390

The higher tree fodder availability in Mangalbare seemed to have led to high milk production where 73% of farmers produced about 47 litres of milk per week per household on an annual basis compared to 45% of farmers and 28% of farmers producing 22 l and 24 l of milk per week in Pokhari and Rajarani. In Mangalbare 45% of farmers sold milk either to the milk collection centres or in the local markets while sale of milk in Pokhari and Rajarani was almost non-existent.

The quantity of fodder produced from cultivated *bari* land was calculated for each farmer as an indicator of the intensity of trees and fodder tree management on cultivated land. Farmers in Pokhari had the highest tree fodder productivity with 7 140 kg ha^{-1} *bari* land and the lowest production was in Mangalbare with only 2 730 kg ha^{-1}. Fodder produced in Rajarani and Solma was 3 660 and 5 820 kg ha^{-1} respectively. The tree fodder productivity was slightly higher for the food sufficient farmers (5 400 kg ha^{-1}) compared with the food insufficient farmers (4 650 kg ha^{-1})..

2.5 Results

Farmers' responses to questions were systematically categorised by topic and then tabulated. Mention of a topic or the factors affecting it was considered a positive

[12] The figures were converted from *bhar*i which refers to a load to be carried on the back. One bhari is approximately 30 kg but is likely to vary with the person carrying it.
[13] A buffalorepresents 1.5 LSU; a cow 1 LSU and a sheep or goat 0.2 LSU (Dutt, 1979)

response. The final table was entered as binomial data. The data were analysed in Genstat using logit modelling (Table 6).

Table 6. An example of knowledge distribution data analysis

A. Data tabulation (Crown density for *Tapkan*)

	Food :	sufficient		insufficient		***Margin***	
Category		Respndts	%	Respndts	%	***Respndts***	***%***
Site	Sex						
Mangalbare	Female	5	50	7	54	***12***	***52***
	Male	2	22	4	50	***6***	***35***
	Margin	*7*	*37*	*11*	*52*	***18***	***45***
Pokhari	Female	10	67	11	73	***21***	***70***
	Male	12	80	5	33	***17***	***57***
	Margin	*22*	*73*	*16*	*53*	***38***	***63***
Rajarani	Female	6	40	4	27	***10***	***33***
	Male	4	27	1	7	***5***	***17***
	Margin	*10*	*33*	*5*	*17*	***15***	***25***
Solma	Female	7	47	9	56	***16***	***52***
	Male	7	47	5	33	***12***	***40***
	Margin	*14*	*47*	*14*	*45*	***28***	***46***
Margin	***Female***	***28***	***51***	***31***	***53***	***59***	***52***
	Male	***25***	***46***	***15***	***28***	***40***	***37***
	Margin	***53***	***49***	***46***	***41***	***99***	***45***

B. Accumulated analysis of deviance

Change	d.f.	deviance (χ^2 statistic)
+ Site	3	18.429
+ Sex	1	5.049
+ Category	1	1.556
+ Site.Sex	3	0.329
+ Site.Category	3	4.283
+ Sex.Category	1	2.549
Residual	208	271.778
Total	220	303.973

C. Proportions (±SE) of farmers having knowledge about crown density influencing *tapkan* and contrast between sites (contrast range = mean ± 1.39 SE)

Site	Mean	SE	Ranking	Solma	Rajarani	Pokhari
Mangalbare	0.45	0.079	3		*	
Pokhari	0.63	0.062	1		*	
Rajarani	0.25	0.056	4	*		
Solma	0.46	0.064	2			

*: significant at *p*=0.05

The deviance (χ^2 statistic) was used to test the significance of the variables in the models. In cases where site was significant at *p*=0.05, further analysis was carried out to predict values for different sites. The predictions along with their standard errors were then used to analyse the differences between each pair of sites. Comparison between the means was achieved by calculating the width of the intervals to achieve a 5 % significance level as

±1.39σ (Goldstein and Healy, 1995) where σ is the standard error of the sample mean. An example of the process followed for data analysis is presented in Table 6.

2.5.1 Tapkan and its effect on crops

The concept of *tapkan* was understood by almost every farmer interviewed and farmers in general were able to classify tree species fairly easily based on the intensity of the *tapkan* effect they observed on adjacent crops and soil. Farmers' understanding and interpretation of factors affecting *tapkan* was very similar across all test sites and was largely based on tree phenology and architecture. The tree attributes which were reported to influence *tapkan* intensity are listed in Table 7. Several new attributes in addition to the attributes already included in the knowledge base were reported by the farmers during knowledge distribution testing.

Table 7. Farmer knowledge about tree attributes influencing *tapkan* attributes in italics did not occur in the original knowledge base.

Tree attribute	Percentage of farmers reporting attribute (n=221)	Significant differences between levels within categories (*p*=0.05)		
		Site	Sex	Wealth
leaf size	92.8	*		
number of leaves[†]	48.0			
crown width	46.2			
crown density	44.8	*	*F	
tree height	25.8			
leaf texture	21.7	*		
number of branches[†]	8.6			
leaf inclination	6.8			
leaf shape	6.8			
leaf rigidity	3.2			
root water absorption rate	2.7	*		
branch width	0.5			

*indicates a significant difference (p=0.05) levels within a category and the letter after it indicates the level with the higher response (M=male; F=female; S=food sufficient; and U=food insufficient group).
[†]contributes to and, therefore, may not be usefully distinguished from crown density

Almost everybody mentioned leaf size, about half of the respondents also mentioned the number of leaves, crown size and crown density while around a quarter of respondents mentioned tree height and leaf texture. Less than 10% of people mentioned number of branches, leaf inclination angle and leaf shape.

The knowledge about the leaf size influencing *tapkan* was ubiquitous as was previously observed by Thapa (1994) in his knowledge representativeness testing in Solma. Crown density, on the other hand while mentioned by a majority of farmers in Thapa's research was cited by less than half the sample population in the present study and the sites were significantly different in the proportion of farmers reporting the attribute. Almost two thirds of the farmers in Pokhari mentioned crown density while only a quarter did in Rajarani. Significantly more female (52%) than male (37%) farmers reported crown density as an attribute influencing *tapkan*. However, some other characteristics, such as the number of leaves and branches and leaf size could be expected to influence crown density. When these contributing factors are considered then crown density was implicitly mentioned by almost all farmers and no differences were observed between site, sex or category of farmers. The apparent differences may, therefore, reflect differences in how people expressed their knowledge rather than what they knew.

Knowledge about crown width influencing *tapkan* was held by nearly half the farmers, while leaf texture was reported by less than a quarter of them overall but the proportion of Solma farmers having this piece of knowledge was significantly higher than for other sites. Knowledge about tree height and leaf texture was less common with about a quarter of the farmers mentioning these while knowledge about leaf inclination angle and leaf shape was sparse with less than 10% of farmers citing them and knowledge about rate of water absorption through roots and leaf rigidity was very rarely mentioned (< 5% of farmers). In general all farmers were aware of the effect of tree *tapkan* on associated crops (maize and millet) although knowledge about exact crop parameters affected varied significantly amongst sites (Table 8). Crop plants under the influence of tree *tapkan* were observed to be weak and unhealthy by the majority of farmers and this may include perceptions about shade as well as *tapkan* effects. Fewer farmers in Solma, however, reported this. Knowledge about *tapkan* affecting the growth rate of crops and physically damaging crops by stripping off leaves, flowers and fruits and uprooting of plants was common although the latter effect was reported by significantly fewer farmers in Rajarani than at other sites. Knowledge about most other effects was fairly common. Significantly more female than male farmers had knowledge about the *tapkan* effect on grain fullness, grain number per head and per cob and crop health.

Almost all farmers mentioned plant health, the majority mentioned crop growth rate, physical damage, stem strength, grain number, crop lodging and head size. Roughly one quarter to a third of farmers mentioned grain size, crop maturation period, grain fullness and number of cobs. Less than 10% of farmers reported etiolation, up-rooting of crop plants, increased pest infestation and stripping off crop leaves, flowers and fruits.

Knowledge about regular fodder lopping reducing the effect of *tapkan* was widespread. However, significantly fewer Pokhari farmers and significantly more female farmers were aware that *tapkan* can be reduced by deliberate pruning of fodder trees.

Table 8. Farmers' knowledge about effects of tree *tapkan* on crops nearby.

Crop attribute	Percentage of farmers reporting attribute (n=221)	Significant differences between levels within categories (*p*=0.05)		
		Site	Sex	Wealth
plant health	95.5	*	*F	
plant growth rate	64.3			
physical damage	62.0	*		
stem strength	59.3	*		
grain number per head	56.6	*	*F	
crop lodging	53.8	*		
head size	48.9	*		
grain size	39.8	*		
crop maturation period	33.5			
grain fullness (*chimro*)	24.4	*	*F	
number of cobs	21.7	*		*S
etiolation	9.5	*		
seed germination rate	6.8			
up-rooting of crop	5.4	*		
strip off leaves, flower and fruits	3.6	*		
higher pest infestation	3.6			

*indicates a significant difference (p=0.05) levels within a category and the letter after it indicates the level with the higher response (M=male; F=female; S=food sufficient; and U=food insufficient group).

2.5.2 Tree rukhopan and its effect on crops

Every farmer interviewed was aware of the concept of the *rukhopan* of trees on farmland and this was based on their observation of the intensity of effect of a standing tree on nearby crops. The primary tree attributes influencing *rukhopan* of a tree were decomposition rate of its fallen leaves, root density near the ground surface, rooting depth and horizontal root spread. Less frequently reported attributes included nutrient content of fallen leaves and nutrient/moisture absorption rate of trees. For most attributes reported, there were significant differences between the proportions of farmers holding the knowledge (Table 9) but there was no consistency in a particular site having more knowledge than others. More female than male farmers seemed to hold knowledge about the tree attributes influencing its *rukhopan* although this was statistically significant only in the case of the size of surface roots. Similarly, only in the case of rooting depth of trees did more food sufficient farmers report the knowledge than food insufficient farmers.

Table 9. Farmers' knowledge about tree attributes affecting *rukhopan* of trees.

Tree attribute	Percentage of farmers reporting attribute (n=221)	Significant differences between levels within categories (*p*=0.05)		
		Site	Sex	Wealth
rate of leaf decomposition	89.6	*		
root density	85.1			
horizontal root spread	76.9			
size of surface roots	65.2	*	*F	
tapkan/shading intensity	47.5	*		
rooting depth	46.2	*		*S
nutrient content of fallen leaves	23.1			
rate of nutrient/moisture absorption by roots	15.4	*		
decomposition rate of fallen fruits	3.6	*		
rate of root decomposition	0.9			
fallen leaves covering crop seedlings	0.9			

*indicates a significant difference (p=0.05) levels within a category and the letter after it indicates the level with the higher response (M=male; F=female; S=food sufficient; and U=food insufficient group).

The effects of a *rukho* tree were well known to all farmers and these effects were almost identical to the reported effects of *tapkan*. Knowledge about *rukho* trees affecting crop growth rate was widespread although effects on crop head size and number and grain size and number were less frequently reported (Table 10). The distribution of knowledge about grain fullness, the size and number of grains per head, the size and number of heads per plant, crop growth rate, crop health, stem strength and physical damage to crop plants varied significantly amongst sites. On average more farmers in Pokhari had knowledge about effects of *rukho* trees than farmers from other sites. Although more female than male farmers consistently reported knowledge about the effects, no significant differences were observed. Similarly, there was no observable difference between knowledge held by farmers in different wealth categories. In summary, site was important in explaining the difference in knowledge about effects of *rukho* trees on crops among farmers, while sex and wealth categories had no effect.

Table 10. Effects of *rukho* trees on nearby crops reported by farmers.

Crop attribute	Percentage of farmers reporting attribute (n=221)	Significant differences between levels within categories (p=0.05)		
		Site	Sex	Wealth
crop growth rate	80.1	*		
number of grains per head	54.8	*		
head size	45.7	*		
grain size	36.6	*		
weak stem	29.4	*		
number of heads per plant	24.9	*		
crop health	19.5	*		
crop lodging	18.1	*		
seed germination	17.6			
crop maturation period	16.7			
grain fullness (*chimro*)	14.9	*		
vegetative growth	1.8			
pest infestation	1.4			

*indicates a significant difference (p=0.05) levels within a category and the letter after it indicates the level with the higher response (M=male; F=female; S=food sufficient; and U=food insufficient group).

Three methods were reported which were known to reduce *rukhopan* of a tree. Very few farmers (4.5%) said than regular lopping was an effective way. The deliberate pruning and shaping of tree crowns as well as burning fallen leaves were reported by significantly different proportions of farmers at different sites. Few Pokhari farmers reported pruning while no farmers in the three other sites reported burning of fallen leaves.

2.5.3 Feeding value of tree fodder

Feeding value of tree fodder was reported to be a function of both tree attributes (growth rate, re-growth potential after lopping, foliage production, seasonality and duration of leaf retention, maximum lopping frequency and pest resistance) and fodder attributes (palatability, leaf softness and texture, thorniness, presence of sap, duration of palatability, *posilopan*, *ovanopan*, ability to satisfy appetite, duration of appetite satisfaction and toxicity). The softness of fodder leaves, leaf texture, smell and taste of fodder and presence of thorn and sap were reported as important attributes influencing fodder palatability. Amalgamating these factors into a single palatability attribute, almost all farmers, especially in Solma and Pokhari, mentioned palatability as an important property influencing tree feeding value (Table 11). However, the number of farmers in Mangalbare mentioning palatability or its related factors was significantly lower than for other sites. Likewise, significantly more female than male farmers mentioned palatability, consistent with women being more involved in feeding fodder to animals. Details of factors influencing fodder palatability was considered in Section 2.5.4. Knowledge about *posilopan* was widespread in Pokhari and Solma while in Mangalbare and Rajarani this was less commonly mentioned. The *ovanopan* attribute was mentioned much less often than the *posilopan* attribute in this context (23% of farmers in Solma,17%in Mangalbare and <7% in Pokhari and Rajarani).

Table 11. Farmers' knowledge about tree and fodder attributes influencing fodder quality.

Fodder/tree attribute	Percentage of farmers reporting attribute (n=221)	Significant differences between levels within categories (*p*=0.05)		
		Site	Sex	Wealth
palatability	96.8	*		
posilopan	82.4	*	*F	
length and season of leaf retention	16.3	*	*M	
ovanopan	13.1	*		
foliage biomass	12.7		*F	
leaf texture	10.4	*		
leaf softness	9.5	*		
duration of palatability	8.6			
toxicity	5.0			
presence of plant sap	3.2	*	*M	
tree growth rate	2.7			
maximum lopping frequency	2.3	*		
thorniness	1.4			
shoot regrowth after lopping	0.9			
ability to satisfy appetite (*bhundi ukasne*)	0.9			
pest resistance	0.5			
duration of appetite satisfaction (*adilo*)	0.5			

*indicates a significant difference (p=0.05) levels within a category and the letter after it indicates the level with the higher response (M=male; F=female; S=food sufficient; and U=food insufficient group).

Other attributes included duration that fodder was palatable, length and season of leaf retention, foliage production, maximum lopping frequency, pest resistance, toxicity, ability to satisfy appetite (*bhundi ukasne)*, and the duration of appetite satisfaction (*adilo*), tree growth rate and shoot regrowth of trees following lopping. The proportion of Solma farmers mentioning length and season of leaf retention was significantly higher than for other sites while the overall proportion of male farmers mentioning this was higher than for female farmers. Knowledge about fodder lopping frequency and foliage biomass were, however, mentioned by a significantly higher proportion of female than male farmers. This is contrary to expectations based on division of labour, where men are more involved in cutting fodder from trees than women and, therefore, might have been expected to know more about it. There were no significant differences observed in knowledge held by the two wealth categories.

Very few responses were obtained on methods of improving the feeding value of poor tree fodders. Wilting was the only method reported for ameliorating undesirable effects of fodder (a tendency for it to stick in animal's throats, *ovanopan* status and low palatability). However, sprinkling of saline water over fodder to increase its palatability was reported by one farmer.

2.5.4 Tree fodder palatability

Among the attributes known to influence tree fodder palatability, fodder taste and smell was most commonly cited; knowledge about leaf texture was common; while knowledge about leaf softness and *posilopan* among the farmers in all four sites was uncommon (Table 12). Very few farmers (about 6.3% overall) reported presence of plant sap influencing the *posilopan* nature of fodder. None of the farmers interviewed in Mangalbare mentioned this property being important in fodder palatability. *Ovanopan* was cited by more food sufficient farmers than food insufficient farmers. Other nutritive and anti-nutritive factors were also reported by a few farmers but there were no other significant differences in site, sex or wealth category. Methods of increasing palatability of tree fodder were virtually unknown, only a handful of farmers (<2%) said that wilting could be effective.

Table 12. Fodder attributes influencing palatability reported by farmers.

Fodder attribute	Percentage of farmers reporting attribute (n=221)	Significant differences between levels within categories (*p*=0.05)		
		Site	Sex	Wealth
taste/smell	76.0			
leaf texture	45.2			
leaf softness	37.6			
posilopan	32.6	*		
ovanopan	11.8			*S
anti-nutritive factors	6.3			
presence of plant sap	3.2			
thorniness	3.2			
toxicity	1.8			
hairiness	1.4			
leaf size	0.9			
leaf greenness	0.5			
fodder unfamiliar to animal	0.5			

*indicates a significant difference (p=0.05) levels within a category and the letter after it indicates the level with the higher response (M=male; F=female; S=food sufficient; and U=food insufficient group).

2.5.5 Posilopan

The terms *posilo* and *kam posilo* as well as the effects of feeding *posilo* and *kam posilo* fodder to large ruminants, particularly on milk and ghee production and animal health, were well known among farmers across the four research sites (Table 13). Knowledge about *posilopan* influencing the proportion of ghee in milk was held by more farmers in Mangalbare than in the other three sites and least in Rajarani. The knowledge about animal fecundity being influenced by *posilopan* of tree fodder was sparse. Knowledge about *posilo* fodder being able to satisfy animal appetite was reported by 83 % of farmers in Pokhari while for Solma and Mangalbare it was less than 10% and no farmers in Rajarani mentioned this attribute.

Table 13. Farmers' knowledge about effects of the *posilopan* attribute of tree fodder on animal productivity.

Effect	Percentage of farmers reporting attribute (n=221)	Significant differences between levels within categories (*p*=0.05)		
		Site	Sex	Wealth
animal health	95.5			
milk production	94.1			
fat content of milk	64.3	*		
fecundity	8.1			
appetite satisfaction	5.0	*		
dung fluidity	2.3	*		
duration of appetite satisfaction (*adilo*)	0.9			
digestibility	0.9			

*indicates a significant difference (p=0.05) levels within a category and the letter after it indicates the level with the higher response (M=male; F=female; S=food sufficient; and U=food insufficient group).

2.5.6 Ovanopan

The effects of feeding excessive *ovano* tree fodder on large ruminant productivity described by farmers was very similar to the effects of *posilo* fodders indicating the close association between the characteristics of *posilo* and *ovano* fodders despite farmers' ability to apply the two systems independently when ranking fodders (Thorne et al, in review). The three major effects reported were changes in milk production, fat content of milk and animal health and there were significant differences between sites (Table 14). In contrast to knowledge about *posilopan* being held by more farmers in Mangalbare than at other sites, knowledge about *ovanopan* was most widespread in Solma. Knowledge about *ovano* fodder leading to dry dung and *chiso* fodder to watery dung was very common in all sites and this is a significant issue in a farming system where the dung is manually collected. The effect on urine quantity was not reported in Rajarani while only a few farmers in other sites mentioned it. More than half of the sample farmers said that wilting made *chiso* fodder more *obano*.

Table 14. Farmers' knowledge about effects of the *ovanopan* property of tree fodder on animal productivity.

Effect	Percentage of farmers reporting attribute (n=221)	Significant differences between levels within categories (*p*=0.05)		
		Site	Sex	Wealth
dung fluidity	75.6			
animal health	42.1	*	*F	
milk production	23.1	*		
fat content of milk	13.6	*		
animal thirst	9.5			*U
urine quantity	5.9	*		
appetite satisfaction	5.4			
indigestion	4.5			
no effect at all	1.4			
sticks in throat	0.9			

*indicates a significant difference (p=0.05) levels within a category and the letter after it indicates the level with the higher response (M=male; F=female; S=food sufficient; and U=food insufficient group).

2.6 Discussion

2.6.1 Site effects

At all four sites, the concepts of *tapkan*, *rukhopan* and *posilopan* were widespread although that of *ovanopan* was less commonly articulated particularly in Mangalbare. This finding was not unexpected as these are the primary factors on which farmers base their decision making about tree fodder resource management. However, there was ample evidence to suggest that the detailed knowledge about the attributes of trees influencing these factors varied considerably amongst sites. Overall, there were significant differences in the number of farmers at different sites articulating knowledge for half of the variables studied.

Amongst the four research sites farmers of Pokhari held most knowledge about tree attributes influencing crop production and the effects of trees on crops nearby. Farmers in Solma and Mangalbare held similar knowledge while farmers in Rajarani held least knowledge. The much higher tree fodder production per unit area of *bari* land in Pokhari (Section 2.4.4) probably means that the tree density was also higher in this VDC. Mangalbare had the lowest tree density and consequently the amount of tree fodder from cultivated *bari* land was also the lowest.

Farmers in Rajarani knew less about tree crop interactions than farmers in other sites. This can be explained by the fact that farmers in Rajarani were not as intensively involved in farming activities as in other sites. It has been stated earlier that for many farmers in Mangalbare farming in the hills was not a primary occupation as many had farms in the Terai and a large proportion of farmers had substantial off-farm income.

Farmers in Mangalbare had more knowledge about tree fodder quality, particularly about *posilopan*, while farmers in Rajarani were less knowledgeable about this. This can be related to the amount of tree fodder produced in the villages. Mangalbare has a tree fodder production of over 9 000 kg per farmer while it was less than a third of this at the three other sites. On the other hand, significantly more farmers in Solma articulated knowledge about the effects of the *ovanopan* property of tree fodder than at other sites whilst Mangalbare farmers were the least knowledgeable about both tree fodder palatability and *ovanopan*. This was perhaps because broom (considered a very *ovano* and palatable fodder and available almost year round) provides nearly 40 % of the tree fodder in Mangalbare. As broom grass is mixed with other fodders throughout the dry season, it is reasonable to assume that knowledge about palatability and *ovanopan* becomes less important where broom is used and consequently less is known about it.

It appears that farmers' knowledge about tree-crop interactions and associated factors depends not only on the number and type of species farmers have experience of, but also on the degree of association of trees with crops on farmland. This is quite logical as the higher the density of trees on cultivated land, the greater is the need for knowledge to manage the components which would otherwise lead to an ineffective system because of tree crop competition.

Broom was known about by every farmer interviewed. Farmers in Solma, Pokhari and Mangalbare considered it a superlative tree fodder although it species was not very common at these sites whereas in Mangalbare it was the primary source of tree fodder. Interestingly, Mangalbare farmers did not view broom as a superlative fodder as they were aware of ill-effects if it was fed in excess to animals. Farmers in the other sites have not reached the stage where it can be fed to animals *ad libitum*. It was evident then that Mangalbare farmers had more knowledge about broom than farmers in other sites, and that their knowledge might be usefully shared with farmers at the other sites.

2.6.2 Gender effects

Overall, there were significant differences according to gender in 10% of the variables studied. In the majority of these cases (80%) female farmers articulated more knowledge than their male counterparts. In an investigation into the knowledge about tree fodder in a village in western Nepal, Rusten (1989) also observed that women had specific interest and more knowledge about trees on *bari* land while men had slightly more knowledge about forest trees. This he explained was due to the fact that men have a greater responsibility for collecting tree fodder from public forest, while women concentrated mainly on trees cultivated on private land. Similar differences in the gender role in fodder management in rural Nepalese households have been reported by Molnar (1981). The present study also revealed that women hold more knowledge about both tree-crop interactions and fodder quality of tree species cultivated on private land.

2.6.3 Economic effects

In only a handful of cases (4%) were there significant differences in the number of farmers articulating knowledge items according to their economic status. In three cases, the food sufficient group was more knowledgeable while in one case the food insufficient farmers were significantly more knowledgeable . There was, therefore, no discernible evidence to suggest that the economic status of a farming household had much effect on the knowledge held by the farmers in it.

2.6.4 Conflict

Sometimes, conflicting statements were made by different farmers. For example, when asked about the effects of feeding large amounts of *ovano* fodder to lactating animals, about 13% of farmers said that this led to an increase in milk production while 5% of farmers expressed the contrary view that it caused a reduction in milk production. The rationale of the first group was that because *ovano* fodder is also *posilo*, it had a positive impact on animal health and thus led to higher milk production. On the other hand, the second group said that because feeding too much *ovano* fodder made the animal thirsty, the actual milk yield was reduced while the fat content in the milk increased considerably. Such conflicting views were encountered in a number of cases. Because detailed articulation of knowledge from farmers was not the primary aim of the investigation, these conflicts were not investigated at greater depth.

2.6.5 Unique knowledge

On a number of occasions, unique knowledge was reported by one or two individuals. Such knowledge is difficult to evaluate as it may either be particularly valuable, as in the case of innovative farmers who develop improvements to the farming system not known by others or it may simply be an artefact. Entry of such rare knowledge in a knowledge base requires some caution since a large number of unconfirmed and doubtful knowledge statements would be undesirable. There is no problem in principle, however, with tagging unique statements that are judged valuable by use of an appropriately modified source label, making it easy to include or exclude them in reasoning procedures.

3 KNOWLEDGEABILITY OF KEY INFORMANTS

3.1 Introduction

Acquisition of knowledge is generally carried out from purposively sampled 'key informants' or 'consultants' considered more knowledgeable than others. Walker (1994) suggested a random sampling of key informants from a pre-identified set of “knowledgeable” farmers. In practice, however, selection of the key informants seems to be based on the ease of access to the farmer and their courtesy (Thapa, 1994; Jinadasa, 1995; Hitinayaka, 1996; Preechapanya, 1996).

It is widely believed that much knowledge is shared within close-knit communities (Werner and Schoepfle, 1987) and it is unnecessary to talk to a large number of people within a community to obtain an articulation of the indigenous knowledge contained therein (Bruce, 1989). Kumar (1987) however, stressed the importance of including key informants from different groups of farmers where knowledge may be affected by variables such as age, ethnicity, gender, location or education. It was observed in Rwanda that farmers considered most knowledgeable by their peers about a diversity of tree species are not necessarily those having the most knowledge of managing these trees in highly integrated tree-crop systems and that there is a strong influence of farmer's socio-economic status in other farmers' perception of how much they know (den Biggelaar and Gold, 1995).

Whether key informants, identified using an emic selection procedure (that is, one based on views within the community about who is knowledgeable) are really more knowledgeable than their colleagues or not is a pertinent issue and has implications for knowledge acquisition strategies. This is particularly important where, even in a small village community, diversity in terms of resource availability and gender exist.

A study was, therefore, conducted to test whether there was any evidence of bias during selection of key informants by farmers and to evaluate the knowledge held by farmers identified as knowledgeable so that it could be compared with the knowledge of other farmers in the same community.

3.2 Methodology

The study was conducted in Solma where the knowledge base augmentation field work had previously been carried out and it was incorporated into the study of knowledge distribution conducted in the VDC and described above. During the wealth ranking exercise in each ward, the key informants were requested to provide names of those farmers which they considered knowledgeable about tree fodder. The names were compiled and twenty random people sampled. Four of the twenty farmers happened to be among the farmers selected for knowledge distribution testing. For the knowledgeability testing, these four farmers were included in the knowledgeable group. Sixteen more farmers were interviewed using the questionnaires used in the main study. The knowledge held by these 20 farmers who had been identified as knowledgeable were compared with that of the 56 farmers interviewed for the overall knowledge distribution study. Data sets were processed and analysed in the same way as for the main study (Section 2.5).

3.3 Results and discussion

Of the total 349 farmers included in the wealth ranking exercise in Solma, 43 % fell into the food sufficient category while the remaining 57 per cent were in the food insufficient category. However, the categorical break-down of the number of knowledgeable farmers proposed by the key informants (Table 15) during the wealth ranking exercise indicated a significant association between the farmer category and the selected farmers. A test of independence between selected farmers and their economic category resulted in a χ^2 statistics of 18.50 which was significant at $p<0.0001$ (1 df). Again among the 62 farmers proposed only 11 per cent were female. This implies that farmers perceived male and more wealthy farmers as more knowledgeable about tree fodder resources although this is not corroborated by the results of the present study (see Sections 2.5 and 2.6) which suggest that if anything women are more knowledgeable than men and wealth has little influence.

Table 15. Food sufficiency category and knowledgeable farmers in Solma VDC.

SE Category	% in VDC composition	% among "knowledgeable" farmers	Male	Female	Total
Food sufficient	43	73	39	6	45
Food insufficient	57	27	16	1	17

In the comparative analysis of the knowledge held by the farmers identified as knowledgeable and other farmers, differences in the proportion of farmers articulating particular knowledge was seldom significant. Although on the whole it was observed that farmers identified as knowledgeable were able to report marginally more knowledge than the main sample of farmers, on a number of occasions knowledgeable farmers actually reported less knowledge. Comparison of the mean number of knowledge items articulated by farmers in the main sample with the mean for individual farmers identified as knowledgeable revealed that several of those identified as knowledgeable actually provided less knowledge than the average for the main sample of farmers. A likely explanation is that these individuals had been identified as knowledgeable by their peers because they held respectable positions in the society rather than on the basis of what they knew. In general they were either ex-soldiers or local influential leaders. This points up a general issue with respect to how knowledgeable people at first appear to researchers. Those with a solid educational background and exposure to wider society through travel outside the farming community had communication skills and confidence in their discussions with researchers which may influence the researcher's perception of how knowledgeable they are. Educated farmers may provide answers by guessing what the most logical explanations might be rather than from a basis of observation and experience.

This small study suggests that farmers clearly see more wealthy men as the most knowledgeable in the community about tree fodder. However, the farmer groups carrying out the selection of knowledgeable farmers were mostly dominated by men despite the presence of some females in all groups. Different perceptions may have been obtained if groups with only women in them were asked to identify the knowledgeable farmers in their village. However, conducting such studies, may, in itself be seen as a challenge to men in the community, who are most often the household heads and village leaders.

Farmers identified by their peers as knowledgeable in the current study did not appear to know substantially more than farmers in the general sample suggesting that elaborate methods to obtain an emic identification of knowledgeable people are not merited. However, exclusion of farmers from the knowledgeable group who may have been selected because of their respected position in the society despite a limited knowledge about the study domain, may reveal a wider difference in knowledge held by the knowledgeable and ordinary farmers. Essentially this suggests that people may be identified as knowledgeable either because they are known to be knowledgeable or because they have high social status or, of course, both. There is no obvious objective means of distinguishing people of high status who are also knowledgeable although this may be done subjectively by the researcher. People who are identified as particularly knowledgeable and are not of high status, however, appear to constitute a reliably knowledgeable group.

4 GENERAL CONCLUSIONS

New knowledge was encountered in the process of exploring the relevance of the knowledge acquired from Solma at three other contrasting sites and location had a far larger influence on what people knew than either gender or wealth. Furthermore, how knowledgeable people at a particular site were about a resource was related to how dependent they were upon it.

Differences in knowledge amongst sites were, however, related to detailed information about specific attributes of trees and tree fodders and their effects, whereas, overall concepts and the terminology used to discuss them were common across sites. Thus, while general classification of trees with respect to their interactive effects on crops (the *tapka*n and *malilo-rhuko* concepts) and of fodders (the *posilopan* and *ovanopan* concepts) were ubiquitous across a wide geographical area, knowledge about particular species was dependent on how important they were to farmers at different sites. Most species occurred at most sites but their use varied according to the characteristics of the farming system.

The commonality of the basic concepts used over a wide geographical area is an important finding as it confirms early assumptions involved in developing formal representations of local ecological knowledge about the generality of farmers' knowledge (Walker *et al*.,1991) and suggests that an investment in understanding the pattern of knowledge held by farmers is worthwhile because it may have a wide applicability. There is some controversy regarding the generality of local knowledge and the extent to which farmers' knowledge is bound to its cultural context as opposed to the real world observations and experience that farmers have. On the one hand some ethnobiologists have found general patterns in how people view nature, as in Brent Berlin's (1992) elegant exposition on the common elements of plant and animal classification in non-literate societies. Other anthropologists assert the primacy of the cultural context, seeing local knowledge as a set of culturally constructed, often unique and idiosyncratic images, little constrained by the parameters of the outside world (see, for example, Geertz, 1983). Gurung[14] (pers. comm.) has recently stressed the cultural dimension of local knowledge across the Himalayan region and examples of deep cultural beliefs affecting farming decisions abound. For example, Conklin (1954), in his seminal research on local knowledge, describes elaborate rituals surrounding farming decisions amongst the Hanunoo in the Philippines and the Nobel laureate Miguel Angel Asturias, explores the ancient Mayan Indian belief that people were literally made of maize, so that commercial exploitation as opposed to self-sufficient use of the crop, was considered unacceptable. It appears from the present results, however, that this debate is founded on a false dichotomy. Although decision making may well be embedded in a cultural context, much ecological knowledge that informs but does not necessarily entirely determine decisions, appears to be based on observations of the real world and thus to vary locally with respect to agroecological conditions that determine the flora and how it is utilised by farmers. The present finding, that local knowledge of ecological processes, as well as taxonomic categorisation, can be usefully generalised across farming communities on a regional basis, is corroborated by a shift in thinking more generally, that farmers generate

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objective knowledge about crop-environment interactions as well as empirical technical knowledge about how to farm (Richards, 1994).

The results of the present research indicate that, on the one hand, there is a need to stratify detailed knowledge acquisition during the compilation phase (see Figure 1) according to site but, that on the other hand, if initial stages of scoping and definition are located at a site where people are heavily dependent on the resource in question, then a template useful for collecting knowledge across a broad geographical area can be developed. Sample sizes at each site may be relatively small (say, around ten people) in the scoping, definition and compilation phases. It is clearly more important during compilation, within resource constraints, to include more sites than more people at any one location, since knowledge varies more amongst sites than within them.

The informants at each site can be selected on the basis of the researcher's perception of how much they know and are likely to articulate, since there is little evidence that more elaborate methods improve how knowledgeable the sample is. However, since there were significant differences in knowledge according to gender, with women generally more knowledgeable than men about some detailed areas of tree-crop interactions and feeding value of tree fodder, samples at each site should include an equal number of men and women, with a gender sensitive approach to knowledge acquisition, specifically ensuring that women can articulate their views without men being present.

The generalisation phase - where the distribution of knowledge is explored - requires sampling across sites reflecting the full range of resource dependence, from which opportunities for sharing knowledge amongst sites may be identified. Opportunities for augmenting the knowledge base during generalisation should be enabled. For example, in the present study, knowledge about broom available at Mangalbare but not at the other three sites may be appropriate for dissemination. However, care is required here since lack of knowledge at the other sites may reflect their different needs - knowing about broom may be unimportant to those communities. Opportunities for dissemination should, therefore, be identified by considering both what people know and what they need to know. Having said this, it is likely that opportunities for sharing will occur on the basis that farmers in any location will develop knowledge on the resources upon which they are most dependent but still utilise a broader set of species, for some of which there may be detailed knowledge available from other sites.

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