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IN THE FIELD

Eliciting indigenous knowledge on tree fodder among Maasai pastoralists via a multi-method sequencing approach

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Abstract. Although the potential of indigenous knowledge in sustainable natural resource management has been recognized, methods of gathering and utilizing it effectively are still being developed and tested. This paper focuses on various methods used in gathering knowledge on the use and management of tree fodder resources among the Maasai community of Kenya. The methods used were (1) a household survey to collect socio-economic data and identify key topics and informants for the subsequent knowledge elicitation phase; (2) semi-structured interviews using key informants to gather in-depth information; (3) tree inventory to collect quantitative data on the ecological status of trees and shrubs on rangelands; and (4) group consensus method to countercheck information elicited from key informants. Study results obtained show that the use of multiple methods in an appropriate sequence is an effective way of building upon the information elicited from each stage. It also facilitates the collection of different types of data and knowledge allowing a measure of triangulation, which can be used to confirm the validity and consistency of indigenous knowledge. Multiple methods also allow the collection of more knowledge than can be obtained if only one method is used. Therefore, it is recommended that future studies on indigenous knowledge systems use multiple methods that combine both individual and group interviews in order to obtain more complete and accurate information.

Key words: Indigenous knowledge, Kenya, Maasai, Multiple elicitation methods, Pastoralists, Tree fodder resources

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Introduction

About 75% of Kenya's geographical area is classified as arid and semi-arid, which supports about 30% of the human and 50% of the livestock population of this country (KEFRI, 1987). About 90% of the population in this climatic zone is rural and dependent on pastoralism (Barrow, 1991). Throughout the centuries, these communities have accumulated indigenous knowledge[1] about their natural resource base, which has enabled them to survive the often harsh environmental conditions (Barrow, 1990). It is complex and based on a wide range of survival and insurance measures that help mitigate against the inevitable hard times due to drought and disease (Barrow, 1991). Until recently, both human and livestock densities were low in these areas. However, high growth rates over the last decade, coupled with the in-migration of non-pastoral tribes[2] from the high potential areas and the sub-division/privatization of the group ranches, have influenced the lifestyles of the pastoral societies (Kimani and Pickard, 1998). The consequences have been overgrazing, land degradation, and loss of high value species.

Land degradation in the rangelands is however a controversial issue (Behnke and Scoones, 1993; Livingstone, 1986). This is because there is not sufficient data to prove long-term degradation. According to Horowitz and Little (1986), singling out the effect of humans, as opposed to that of natural processes such as drought and climatic change, is not easy. Even short-term studies, according to Homewood and Rogers (1987), cannot show the relative impacts of different management systems on declining productivity. Even without sufficient data, many scholars such as Sindiga (1984), Odundo (1992), Glanzt (1994), and Seno and Shaw (2002) are of the view that group ranch sub-division and fragmentation are likely to increase the potential of land degradation and loss of valuable species as a result of clearing vegetation for cultivation, charcoal burning, and grazing. Continuous grazing, which is likely to occur on the sub-divided ranches, will not allow enough time for forage recovery. So despite the long-term sustainability of pastoral land management systems, they are in a real danger of breaking down. Urgent measures therefore are needed to avert the problems that are facing the rangelands.

Why study indigenous knowledge?

In an effort to improve pastoral land management systems, donor agencies have spent millions of dollars over the last two decades on research and development programs. However, most of these programs have been unsuccessful (Swift, 1977; Fry and McCabe, 1986). In many cases, this lack of success can be linked to the fact that scientists and development planners failed to discuss problems and potential solutions with the recipients of research and development. They overlooked the knowledge of the very communities that have lived in these environments and managed their natural resources on a sustainable basis (McCabe, 1987, 1990). According to Barrow (1991), development practitioners also held the traditional attitude that rural people are "backward," and therefore development should be planned and implemented for them.

The failure of many of the development programs in pastoral areas influenced researchers and development agents to re-examine the validity of the assumption upon which the projects/programs were based. Reconstruction of a more sustainable natural resource management system led development professionals such as Chambers (1983), Barrow (1990), Den Biggelaar (1991), and Scoones and Thompson (1994) to argue that more attention needs to be given to local knowledge systems and rural people's participation in community-based programs. Among the advantages of such participation are (1) the design of appropriate interventions that are technologically feasible and culturally acceptable; (2) the preservation of indigenous knowledge and skills; and (3) ensuring that local people take charge of their destinies.

During the last decade, indigenous knowledge has become a subject of considerable interest to development professionals all over the world (Blaikie et al., 1997; Sillitoe, 1998; DeWalt, 1999; Warren, 1999). Previously, a preserve of ethnobotanists, indigenous knowledge research is now pursued by all disciplines interested in "bottom up" approaches to development. According to Davis and Wagner (2003), this is because indigenous knowledge is thought to offer an alternative to the "top down" natural resource management regimes. Indigenous rights movements in some countries, notably, the Aborigines of Australia and the Native Americans of the United States have also pressured their governments to reintegrate indigenous knowledge into the management of the natural resources (Ross and Pickering, 2002). Davis and Wagner (2003) argue that the fact that these indigenous movements are being "heard" reflects, to a large extent, the recognition of the importance of indigenous knowledge in sustainable management of natural resources throughout the world.

Indigenous knowledge research in pastoral systems

A review of the literature demonstrates that there has been a growing interest in indigenous knowledge of natural resource management in pastoral systems (Bayer, 1990; Bollig and Schulte, 1999; Ego et al., 1999; Ayatunde et al., 2000; Kunene et al., 2003; Mapinduzi et al., 2003; Kiringe and Okello, 2005). Mapindinzi et al. (2003) used Maasai indigenous ecological knowledge to assess rangeland biodiversity in Tanzania. They noted that indigenous systems of land classification provide a valuable basis for assessing rangeland biodiversity and should be incorporated into future ecological surveys of rangelands. On the other hand, Bollig and Schulte (1999) in their studies on environmental change and pastoral perceptions among the Pokot pastoralist of Kenya and the Namibian Himba, added another perspective to the debate on environmental degradation in pastoral areas. They found that the knowledge of the two communities was socially construed and embedded in ideology. It relates to a cultural landscape, viewed over time and not to abstract considerations of climax vegetation, as is often viewed by scientists. According to their findings, the Pokot do not consider overgrazing to be a major cause of environmental degradation but rather to be the result of societal conflicts. Kiringe and Okello (2005) assessed the use and availability of tree and shrub resources on Maasai communal rangelands near Amboseli National Park, Kenya. They found a decline in tree and shrub cover mainly as a result of charcoal burning, agricultural expansion, and fencing and recommended regular monitoring in order to avert the over-exploitation of valuable species. Kunene et al. (2003), in their studies of tree and livestock production in KwaZulu-Natal, South Africa, found that some farmers relied heavily on their ethno-veterinary knowledge to treat worm infestation and coughs among their livestock. Some of the KwaZulu-Natal farmers even had planted species on their farms known to have medicinal value and to increase milk production. However, not all the farmers interviewed by Kunene et al. (2003) had knowledge of the benefits of important trees and shrubs and the authors recommended that more research of this sort be done so that the potential benefits of trees and shrubs might be realized.

Although the studies mentioned above have looked at different aspects of indigenous knowledge systems, all have one thing in common. They have increased our understanding of the complex agro-ecological system of pastoral areas. This understanding will contribute to efforts of improving existing pastoral systems and devising alternative land-use strategies that are responsive to local needs.

Indigenous knowledge, tree fodder research, and methodological concerns

There is also a growing interest in indigenous knowledge of tree fodder resource utilization by local communities, as evidenced by the increasing number of studies[3] (Rusten and Gold, 1991; Thapa et al., 1995; Ego et al., 1999; Roothaert and Franzel, 2001). Thapa et al. (1995), in investigating farmers' knowledge of the management and use of tree fodder in the eastern hills of Nepal, found that farmers possess detailed knowledge of tree fodder quality and tree fodder management techniques which they use in making decisions concerning fodder management and feeding strategies of 90 tree species. In Kenya, a notable example of tree fodder research is that of Roothaert and Franzel (2001), who studied farmers' preference and use of local fodder trees and shrubs among the Aembu and the Mbeere people of eastern Kenya. They documented various criteria that farmers used in evaluating fodder species. Similarly, Barrow (1990), in his description of the research on an indigenous system of knowledge developed by the Turkana of Kenya, found that the Turkana possess extensive knowledge about individual tree species and their management. While investigating the ecological strategies of the Pokot pastoral communities in dryland Kenya, Barrow (1988) found that their understanding of individual plants was highly developed in the selection of fodder. The Pokot were able to identify species that provided dry or wet season fodder, increased the production of meat or milk, and provided suitable nourishment for specific categories of livestock.

The studies mentioned above however have focused mainly on indigenous knowledge elicited and how it can be used in development, but few provide detailed information on the methodologies employed. A similar observation was made by Davis and Wagner (2003) in their review of the most recent literature on research design and methodology on indigenous knowledge research. They noted that most indigenous knowledge researchers often fail to provide detailed descriptions of their methodologies. Most give a minimal description of the methods used, usually mentioning the research tools used and the number of informants involved, and offering very little critique, if any, on the methods. Among the research mentioned above on tree fodder research, only Rusten and Gold (1991), Walker et al. (1995), and Roothaert and Franzel (2001)[4] have discussed methods used in eliciting indigenous knowledge in detail. Rusten and Gold (1991), in their study of an indigenous knowledge system underlying the management of fodder in Nepal, used five methods, namely (1) a household survey, (2) participant observation (3) tree inventory (4) semi-structured interviews with key informants and (5) a repertory grid and triad tests. In their critique, they argued that since indigenous knowledge systems are very complex, no single method can capture the complexity. They recommended the use of multiple methods in indigenous knowledge systems research as they allow the cross-checking of anomalies and problems that may arise from one method. Similar observations were noted by Den Biggelaar and Gold (1995) in their study of endogenous agroforestry knowledge in Rwanda. Since there is very scanty information on methodologies used in indigenous knowledge research, it is important that more methods are documented to improve the research process and the quality of information obtained. This study reported here, therefore sought to use multiple methods in an endeavor to capture detailed indigenous knowledge about tree fodder utilization among Maasai pastoralists. In addition to a household survey using a structured questionnaire, a tree inventory and semi-structured interviews with key informants, it used the group consensus method.

One of the objectives of this research, therefore, was to use multiple methods and analyze their suitability for eliciting indigenous knowledge. The other specific objectives of the study were to

(1) examine how pastoralists perceive the value of fodder species and the criteria used in evaluation, and
(2) recommend the extent to which indigenous knowledge can be used in planning appropriate tree fodder research and development strategies for the improvement of tree fodder resource management in the rangelands.

This paper discusses indigenous knowledge elicited from Maasai pastoralists of Kajiado district, Kenya between 1999 and 2001 and the methods used in gathering it. An attempt has been made to give a critique of the methods in the context of this research.

Description of research site

The research was conducted in Mashuru division, Kajiado district, Kenya[5] (Figure 1). The district covers an area of 21,105 km^2, which is 3.5% of the total area of

Figure 1. Map of Kenya showing Kajiado District (shaded area).

Kenya (MPND, 1997). Mashuru, one of the five administrative divisions of Kajiado district, covers an area of 2250 km^2. Mashuru division receives an average annual rainfall of 500 mm in a bimodal pattern and is characterized as a semi-arid region. The rainfall is low, highly erratic, and varies from season to season. Rainfall fluctuates greatly, and the onset of the rains is unpredictable. It is usually concentrated in a few intense showers causing severe runoff.

Mashuru division is inhabited mainly by the pastoral Maasai who comprise 75% of the total population (Ego et al., 1999). The raising of livestock continues to be their principal activity, and they view it as security against famine, as a dowry resource, and as a source of prestige. They practice very little farming (a few have made unsuccessful attempts) and largely depend on the products of their livestock – directly through the consumption of meat and milk supplemented by blood during the dry season or indirectly through the purchase of maize meal, other essential household goods, and inputs for livestock production.

The vegetation of Mashuru is predominantly wooded grassland, open grassland, and semi-desert bushland and scrub. The dominant tree species are *Acacia tortilis*, *Acacia drepanalobium*, *Balanites aegyptiaca*, *Acacia mellifera*, and *Commiphora africana* (Ego et al., 1999). Due to the harsh environmental conditions often experienced in Maasai land, trees and shrubs play an important role in the Maasai livelihood system as they have the ability to tolerate a wide range of management practices and produce fodder when other species (grasses and herbs) have become dormant. They are a source of food, fodder, medicine, and construction materials while assisting in the maintenance of catchments, soil fertility, and soil protection. They also play a symbolic and ritual role (Ego et al., 1999). For instance, only the bark and leaves of certain trees may be used in "purification" ceremonies to avert supernatural misfortunes (*naipok*). As a result of this dependence on trees, the Maasai have accumulated extensive knowledge about individual tree species used for fodder.

Kajiado, which is 92% rangeland, also supports wildlife such as antelopes, giraffes, wildbeasts, hyenas, buffaloes, and zebras. About 65–80% of Kenya's wildlife live outside designated conservation areas (World Bank, 1994). This is significant for Kajiado because the Amboseli National Park, which is within the district, and Nairobi National Park, which borders Kajiado, cannot support all the wildlife, and therefore the adjacent rangelands form the main wildlife dispersal area for both resident and migrant species (Kimani and Pickard, 1998). Wildlife have coexisted with the Maasai for centuries although they are now threatened as a result of the privatization/sub-division of ranches. Sub-division began in Kajiado in 1983, after the government enacted a policy in its favor (Grandin, 1986). One consequence of ranch sub-division is the conflict between wildlife and farming. Cultivators have had no choice but to fence off land in order to keep wildlife from destroying their crops. The fences restrict wildlife movement. According to Odundo (1992), fencing in certain parts of Kajiado is already interfering with traditional migration patterns of wildlife.

Description of methods used

Four survey methods were used in this study to elicit indigenous knowledge on the use and management of tree fodder resources. These methods were (1) a household survey using a structured questionnaire, (2) semi-structured/informal interviews with key informants, (3) a tree inventory, and (4) the group consensus method.

Household survey

A random sample of 60 households across the seven locations of Mashuru division was carried out, and heads of households (all men) were interviewed using a predesigned questionnaire. Their ages ranged from 30 to over 70-years-old (Table 1). The sample was picked from a list of 300 households that had been prepared by chiefs and their assistants. A household in this case consists of one man, several wives, and their children. Women were purposively left out in this study because in the Maasai culture, responsibility for herding and managing livestock rests squarely on men. However, there are

Table 1. Age structure of pastoralists interviewed during the household survey and those selected as key informants.

Age (yrs)	# of informants	
	Household survey (n = 60)	Key informants (n = 30)
30–40	12	3
41–50	14	6
51–60	11	5
61–70	17	12
over 70	6	4

exceptional cases where young girls and women are given the responsibility of herding goats, sheep and calves.

The purpose of the household survey was to (1) collect quantitative and qualitative data on the socio-economic conditions; (2) get a general view about pastoralists perceptions and attitudes towards tree fodder; (3) identify key topics that pastoralists had knowledge about; and, (4) identify key informants for the subsequent knowledge elicitation phase. The data gathered was on the following variables: (1) household composition, (2) ownership and control over resources, (3) land and livestock holding, (4) utilization of tree species, and (5) general attitudes of informants towards tree fodder resources.

Interviews usually took place at the informant's homestead, either under a tree or at the watering point and were administered by male interviewers. The Maasai language was used in the interviews. It was normal practice to make an appointment either through the assistant chiefs or village elders 1 or 2 days before the interview. Interview responses were recorded in the questionnaire. At the end of the day, a brief discussion was held with the field assistants to discuss the day's work and the program for the next day.

Choice of key informants

To collect detailed information about tree fodder from informants, the study focused upon a limited number of carefully selected pastoralists referred to as key informants. Kumar (1987) defines key informants as individuals who are likely to provide detailed information, ideas, and insights on a particular topic. The basic principle guiding the research was that not every pastoralist would have the same knowledge of trees, largely as a result of differing biophysical conditions on their rangelands and personal interest. Ego et al. (1999) showed that vegetation types varied within the district as a result of differences in climatic factors and therefore tree species that existed in one locality were not necessarily the same as in the neighbouring location. As the goal of this study was to understand the underlying knowledge on the use and management of tree fodder resources, it was necessary to interact with the most knowledgeable pastoralists. Random sampling was therefore out of the question because it would have meant also interviewing pastoralists with very little knowledge on tree fodder resources. Asking pastoralists to select knowledgeable informants through a ranking exercise as was used by Den Biggelaar and Gold (1995) was also not appropriate because all pastoralists had livestock and access to trees and shrubs on their rangelands and therefore, it was not easy to tell who had more knowledge than the other. Using snowball sampling technique that was used by Neils et al. (1999) was also not suitable because of the dilemma faced by pastoralists of not knowing who was more knowledgeable. The only other suitable option the team was left with was to purposively select knowledgeable key informants on the basis of responses given during the household survey. By so doing, some pastoralists who had no interest at all in answering questions and those who did not know much about tree fodder resources were eliminated. This process resulted in a total of 30 key informants (Table 1).

Semi-structured interviews with key informants

The key informants were interviewed privately and informally to elicit in-depth knowledge. During the interviews, a checklist of key topics, which had earlier been identified from the household survey, was used. Issues that came up from the household survey were divided into four broad topics. These were (1) fodder productivity and availability (i.e., seasonal availability of fodder from different species at different times of the year); (2) priority fodder species; (3) criteria used in evaluating fodder; and (4) fodder toxicity. The checklist was to ensure that important issues were not left out during discussions.

In order to fully elicit knowledge from the informants about tree fodder, the following approaches were adopted: (1) an "emic" approach, which examines issues from the local perspectives without relying on assumptions and also seeks categories of meaning in the local language; (2) an approach that blended together informal interviews (conversations) and observations in order to fully understand pastoralists' perceptions; and (3) an iterative approach whereby interviews consisted of a number of repetitive cycles. After every interview, knowledge was immediately analysed in order to identify gaps, contradictions, and requirements for clarification. As a result, new topics and questions were formulated for the next cycle of interviewing with the same informants. This approach was used to ensure that the knowledge being gathered was relevant, useful, and as complete as possible. Throughout the research, the research team assumed the role of learner, keeping an open mind and suspending judgments during the elicitation process.

During the interviews, individual informants were asked to rank the five most important fodder species and to indicate the criteria they used in ranking. After ranking their preferred species, informants were asked to rate them based on the criteria they had mentioned.

Tree inventory

An inventory of the existing trees and shrubs in the rangelands was carried out using systematic sampling. This was done on the land owned by the 30 key informants. The objective of the tree inventory was to assess species diversity and their ecological structure. Biophysical measurements were taken using nested quadrants of 400 m^2 to study trees and shrubs. In each quadrant, data on density, cover, frequency, and the regeneration status of each species was recorded. Each tree and shrub was recorded by its botanical and local names. Plant identification was done by pastoralists themselves using local names. The methods and detailed results of the inventory are reported elsewhere (Kiptot, 2002).

Group consensus method

To verify the information elicited from the household survey, key informants, and the tree inventory, the group consensus method was used.[6] This entailed using a group of informants rather than relying on individual key informants (Van Willegen and De Walt, 1985; Price, 1997). With the assistance of local leaders, chiefs, and their assistants, one meeting was held in each of the seven locations of Mashuru division. These meetings were comprised only of men, ranging in age from 19 to about 80-years-old. During the meetings, findings from the household survey and the discussions with the key informants and the tree inventory were presented to participants who were asked to give their views and add to the inventory. As a result, the original list of fodder species was expanded and a final list compiled. Participants also were asked to name the 20 most important species according to livestock type. This was done to narrow down the species list for ranking purposes. Participants then were asked to rank the 20 most important fodder species. This was done through a pair-wise matrix ranking exercise. Each species was compared with the rest in pairs and one of the two selected. At the end, the species were ranked according to the number of times they were chosen as the preferred one of the pair. A second ranking of 10 preferred species for each livestock type also was undertaken by pastoralists based on the qualities that had featured in their discussions.

Results and discussion

Land tenure system and land use

Respondents owned an average of 100 ha. Ninety-three percent were initially members of various group ranches and had recently been allocated their own land. A minority (7%) inherited land from their fathers. Although 87% of them have had their land surveyed, 93% have not yet received title deeds. Most of the land is used for grazing; land for cultivation averaged 1.2 ha, while the homestead averaged 0.8 ha. A few pastoralists who border Makueni district have started clearing small portions of land for crop production.

Livestock production and management system

Livestock production has been and remains the main source of subsistence for the Maasai community. Every homestead visited had livestock. The average number of cattle per household in Mashuru was 42, of which 80% were crossbred (between *Sawihal* and the local Zebu). The average number of sheep was 47, goats 42, and donkeys 2. Cattle and shoats are mainly kept for milk, cash, meat, prestige, and security, while donkeys are kept mainly for traction.

The Maasai of Mashuru division have evolved a well-managed system of livestock management in order to ensure a continuous supply of livestock forage throughout the year. They utilize the vegetation on a sustainable basis (except during drought years[7]) through various strategies. These include (1) the use of large diverse rangelands and high mobility (although this may soon change with the sub-division/privatization of the rangelands); (2) the use of tree fodder during the dry season; (3) the use of rotation grazing where wet and dry season grazing areas exist (during the dry season, the pastoralists graze their livestock on hilltops such as Loita hills while during the wet season they graze in the plains); and (4) the use of set aside land and fenced off land in communal areas for grazing reserves known as *olopololis/olales* during critical periods. The difference between olopololi and olale is that the latter is a small portion (less than half an acre) next to the homestead. It is reserved for young calves unable to walk long distances to graze, sick animals (to be cared for and kept isolated from other animals, thus controlling the spread of disease), and a few lactating animals, especially in times of critical grass shortage. These areas are enclosed during the wet season when there is plenty of feed and managed in a way that allows tree species to mature and later become sources of forage and fodder during critical periods. Olopololis/olales are usually managed by individual households and are about one to four hectares each. These holdings are exclusively for individual use and no one is allowed to

Table 2. Number of fodder species used by different livestock as identified by various survey methods.

	(No. of fodder species)			
	Cattle	Goats	Sheep	Donkeys
Household survey (n = 60)	65	75	69	23
Key informants (n = 30)	87	96	90	32
Tree inventory[a] (n = 30)	94	104	95	63
Group consensus[b] (n = 240)	112	154	102	74

Note: There is an overlap both in fodder species used by different livestock and those identified by various methods.
[a]A tree inventory was undertaken in 30 farms owned by key informants.[b]There were 7 group meetings that were undertaken, one in each of the 7 locations of Mashuru division, totaling 240 informants.

graze livestock in a neighbor's olopololi without the owners' permission. The number and size of olopololis per household varies depending on individual initiative, availability of land, and access to labor.

Tree fodder use

The number of species used for fodder is remarkable. A total of 154 indigenous species of fodder trees and shrubs were mentioned (Table 2). Different parts of these species are eaten preferentially by different types of livestock. Donkeys are more selective than cattle, goats, and sheep. All 154 species mentioned were browsed by goats, 102 by sheep, 112 by cattle, and 74 by donkeys. Informants stated that some of the species mentioned played a very important role as sources of browse during dry periods, when grasses and herbaceous vegetation are dormant. These are *Acacia tortilis* (whose pods are available in the dry months of August and September), *Lonchocarpus eriocalyx, Acacia mellifera, Acacia brevispica, Salvadora persica*, *Rhus natalensis, Cordia ovalis*, and *Cordia sinensis.* Because of the large number of livestock involved, the pastoralists do not normally harvest browse for livestock, except in special circumstances (e.g., for sick or lactating animals).

Species ranking by pastoralists

During informal interviews with individual key informants and discussions with group informants, ranking exercises were undertaken in order to identify the best 20 fodder species for each type of livestock. The rankings of some species (e.g., *Grewia tembensis*) differed from one informant to the other, but some species (e.g., *Acacia tortilis*) seemed to receive high rankings quite consistently. The discussions about the best species during the group meetings were often very lively. Because everyone was able to contribute, it created an excellent environment for information exchange and learning. In cases where there were opposing views, each participant was given time to discuss and defend his views. This went on until a compromise was reached. At times, it was difficult to reach a consensus and, in such situations, the species preferred by the majority (as per the matrix scores) would be listed among the priority species.

Results presented in Table 3 show that *Acacia tortilis* was unanimously selected by both key and group informants as the best species for fodder for all four types of livestock. These results are consistent with the work of Barrow (1991) who found that *Acacia tortilis* was also the most important fodder species in the "Turkana" silvopastoral system. Other species browsed by cattle that ranked among the top 10 using both methods were: *Grewia tembensis, Sericomopsis hildebrandtii, Phyllanthus sepialis, Lonchocarpus eriocalyx, Acacia mellifera, Grewia bicolor, Cordia ovalis*, and *Acacia brevispica.* Only one species did not appear on both lists. For species browsed by goats, only *Lippia javonica* did not appear on both lists. For sheep, only two species did not appear on both lists, they are *Rhus natalensis* and *Premna resinosa*. It is interesting to note that the five highest ranked species browsed by donkeys on the key informants list were similarly identified by group informants with slight differences in ranking. These results indicate that the knowledge elicited from key informants was consistent with that from group informants, with only a few differences in ranking which could partly be attributed to differences in judgment.

Acacia tortilis, Acacia mellifera, and *Acacia brevispica* appeared in the top 10 preferred species lists for all types of livestock using both methods. Apart from a common preference for *Acacia tortilis* by cattle, goats, sheep, and donkeys, these animals also have individual preferences. For instance, goats and sheep prefer *Balanites aegyptiaca, Acalypha fruticosa, Aspilia mossambiccensis, Lippia javonica, Premna resinosa*, and *Rhus natalensis*, while donkeys prefer *Barleria eranthemoides, Maerua angolensis, Boscia anguistifolia*, and *Turrae abbyssinica*.

Criteria used by pastoralists for species evaluation

Species evaluation was based on fodder quality and physiological characteristics of the various species

Table 3. Ranking of priority fodder species using two methods.

Livestock type	Botanical names	Maasai names	Informal interviews with key informants[a] (Species rank)	Group consensus[b]
Cattle	*Acacia tortilis*	Oltepesi	1	1
	Grewia tembensis	Oirri	2	5
	Sericomopsis hildebrandtii	Naibor ikunya	3	2
	Phyllanthus sepialis	Esambugige	4	3
	Lonchocarpus eriocalyx	Orpararwai	5	6
	Acacia mellifera	Oiti	6	4
	Grewia bicolor	Ositeti	7	8
	Salvadora persica	Eremit	8	11
	Cordia ovalis	Oseki	9	7
	Acacia brevispica	Orgirgir	10	9
Goats	*Acacia tortilis*	Oltepesi	1	1
	Balanites aegyptiaca	Osarai	2	5
	Acacia mellifera	Oiti	3	6
	Acacia brevispica	Orgirgir	4	2
	Acalypha fruticosa	Osiati	5	4
	Aspilia mossambiccensis	Oloyapasei	6	7
	Grewia villosa	Ormngulai	7	9
	Lippia javonica	Osinoni	8	12
	Premna resinosa	Ormakarakara	9	3
	Rhus natalensis	Ormisigiyoi	10	8
Sheep	*Acacia tortilis*	Oltepesi	1	1
	Aspilia mossambicensis	Oloyapasei	2	2
	Balanites aegyptiaca	Osarai	3	5
	Acalypha fruticosa	Osiati	4	6
	Acacia mellifera	Oiti	5	4
	Lippia javonica	Osinoni	6	7
	Acacia brevispica	Orgirgir	7	9
	Phyllanthus sepialis	Esambugige	8	3
	Rhus natalensis	Ormisigiyoi	9	12
	Premna resinosa	Omakarakara	10	14
Donkeys	*Acacia tortilis*	Oltepesi	1	1
	Berleria eranthemoides	Olkulishashi	2	2
	Maerua angolensis	Enchan osirkoni	3	4
	Boscia anguistifolia	Oleiroroi	4	5
	Turrae ab.byssinica	Enchanyangashe	5	3
	Commiphora eminii	Orupante	6	8
	Acacia mellifera	Oiti	7	10
	Cordia sinensis	Oldoroko	8	12
	Acacia brevispica	Orgirgir	9	11
	Premna resinosa	Ormakarakara	10	6

[a]If an informant ranked a species first, it was given a score of 5, second ranked a score of 4, etc. Sums of individual informants' scores were computed and the species with the highest score was ranked number 1 overall.
[b]The pair-wise matrix scores were used to rank the species during the group discussions.

(Tables 4 and 5). From the pastoralists' perspective, fodder quality is determined by (1) its ability to increase milk production and butter fat content, (2) its ability to fatten livestock, and (3) its palatability. These findings are consistent with studies in Nepal by Rusten and Gold (1991), Thapa et al. (1995), and Thorne et al. (1999) and in Kenya by Roothhaert and Franzel (2001). Physiological attributes that pastoralists also considered are (1) the ability of fodder to satisfy; (2) drought resistance; (3) ability to withstand multiple browsing; (4) forage biomass; (5) fodder availability during the dry season; and (6) presence of both edible fruit/pods and leaves.

Table 4. Key informants' ratings of priority fodder species for cattle across selected criteria.

Species	Effect on milk prod.	Fattening	Drought resistant	Resistant to browsing	Ability to satisfy	Palatability
Acacia tortilis	3.6 (0.54)	3.7 (0.65)	3.8 (0.44)	3.2 (0.47)	1.6 (0.53)	4.0 (0.00)
Grewia tembensis	2.0 (0.60)	2.7 (0.45)	1.8 (0.54)	2.1 (0.58)	2.5 (0.76)	3.1 (0.56)
Sericomopsis hildebrandtii	3.3 (0.78)	3.2 (0.56)	1.4 (0.48)	2.6 (0.94)	1.2 (0.51)	3.6 (0.96)
Phyllanthus sepialis	3.0 (0.57)	2.6 (0.75)	1.3 (0.44)	1.7 (0.78)	1.7 (0.72)	3.6 (0.64)
Lonchocarpus eriocalyx	1.2 (0.44)	1.2 (0.40)	3.1 (0.58)	2.1 (0.88)	3.8 (0.40)	1.5 (0.50)
Acacia mellifera	2.4 (0.56)	1.7 (0.57)	3.4 (0.49)	3.6 (0.43)	1.9 (0.53)	2.8 (0.52)
Grewia bicolor	2.6 (0.44)	2.7 (0.45)	3.0 (0.40)	2.5 (0.50)	2.5 (0.50)	2.4 (0.56)
Salvadora persica	1.3 (0.64)	1.4 (0.56)	3.8 (0.34)	3.5 (0.50)	3.2 (0.43)	2.6 (0.63)
Cordia ovalis	2.0 (0.82)	1.9 (0.94)	3.6 (0.99)	3.4 (0.66)	3.1 (0.45)	1.8 (0.33)
Acacia brevispica	2.9 (0.78)	2.6 (0.64)	3.8 (0.78)	2.5 (0.74)	1.2 (0.37)	2.9 (0.34)

Note: Key informants only rated species that each one of them had ranked. The number of informants rating the species varied from 10 to 30.Mean scores[a] and standard deviations in parentheses.
[a]Farmers were asked to rate species based on selected criteria, a rating of 4 = very good, 3 = good, 2 = average, and 1 = poor.

Table 5. Group informants' ranking of priority fodder species for cattle based on selected criteria.

	Rank					
	Effect on milk prod.	Fattening	Drought resistant	Resistant to browsing	Ability to satisfy	Palatability
Acacia tortilis	1	1	1	1	8	1
Sericomopsis hildebrandtii	2	2	10	9	12	3
Phyllanthus sepialis	3	3	9	10	9	2
Acacia mellifera	6	7	2	2	8	5
Grewia tembensis	8	5	8	5	6	7
Lonchocarpus eriocalyx	12	14	4	3	1	10
Cordia ovalis	5	9	5	4	3	9
Grewia bicolor	9	6	7	7	4	6
Acacia brevispica	4	4	3	6	7	4
Cordia sinensis	7	8	6	8	2	8

Note. The list presented above is of priority species that were ranked based on the sum of matrix scores across the seven group meetings while the rankings of selected criteria was undertaken using 10 priority species per group. This explains why some of the species are ranked beyond number 10. Rankings were based on the sums of pair-wise matrix scores across the seven groups.

A species' ability to satisfy (mentioned by almost every pastoralist) coincided with its having big broad leaves or being a succulent. Succulence and big broad leaves are very important attributes for pastoralists because Mashuru division is dry most of the year, making water and fodder availability a major concern. Fodder palatability was said to be influenced mainly by leaf texture, fodder maturity, and taste of fodder. Fodder maturity mainly referred to unpalatable, unripe pods/fruits and palatable ripe ones. Maturity also was highly linked to taste in that unripe pods/fruits were said to have a "bitter" taste unlike ripe ones. Mature pods of *Acacia tortilis* were said to be salty and hence referred to as "sweet," a quality attractive to both livestock and humans. It is very common to see young children eating the pods of *Acacia tortilis* and fruits of *Balanites aegyptiaca* when in season.

Rating of priority fodder species using selected criteria

The results of species rating by both key informants and group informants were in basic agreement. While there were a few differences, these can be attributed largely to differences of opinion. The results show that *Acacia tortilis*, rated the best fodder species (Table 3), also scored highest with regard to milk production, drought resistance, and palatability (Tables 4 and 5). It did not fair well with regard to its ability to satisfy. *Lonchorcarpus eriocalyx*, which was rated fifth among species that are good for cattle (Table 3), apparently scored highest in only one attribute, the ability to satisfy (Tables 4 and 5). This indicates that pastoralists have a high regard for species that have the ability to satisfy livestock irrespective of their shortcomings. *Salvadora*

Table 6. Fodder tree species considered by informants to cause toxic effects on animal health when consumed in large quantities.

Fodder trees	Stage at which toxic	Animals affected	Extent of effect
Balanites aegyptiaca	Unripe fruits	Goats	Abortion
		Sheep	Diarrhea
Acacia tortilis	Unripe pods	Goats	Abortion
Balanites glabra	Unripe fruits	Goats	Abortion
Acacia nilotica	Unripe pods	Cattle	Abortion in cows
		Goats	Death in goats
Commiphora africana	Young leaves	Goats	Diarrhea

persica, one of the most important species during the dry season, was rated highly in terms of drought resistance, ability to satisfy, and resistance to multiple browsing. These results suggest that pastoralists use multiple criteria when evaluating fodder species and there is no one single species that has all the preferred characteristics. One species, *Acacia tortilis*, scored highest in all attributes except one, the ability to satisfy (Table 5).

Fodder toxicity

Pastoralists had considerable knowledge about the deleterious effects of fodders on livestock health. Knowledge about toxic effects came out strongly in all the forums. Detailed, species-specific knowledge including the extent of deleterious effects and variability of effects according to different stages of leaf and pod/fruit development was articulated by all informants. Some species known to cause negative effects on livestock (including the stage at which they are harmful) are indicated in Table 6. The most common species causing toxicity are the Acacias, especially *Acacia tortilis*, which, ironically, is considered to be the best fodder species in terms of nutrition and physical characteristics.

A critique of methods used

The household survey, using a structured questionnaire, was carried out with the sole purpose of collecting baseline information about the area. As the ultimate purpose was to learn about pastoralists' knowledge of tree fodder, the research team had to first understand the way of life of pastoralists generally and how they perceived tree fodder specifically. It also provided the opportunity for the team to build trust in their personal relationships with the Maasai, a fundamental requirement of the knowledge elicitation process. The obvious advantage of this method was that coverage was broad, administered to a randomly selected sample of the population and, therefore, the views of the pastoralists were representative of the population and the results could be statistically analysed. There were, however, two drawbacks with this method. One was due to the fact that questions were designed by the researcher, and responses were influenced to a large extent by the researcher's perspective rather than that of the informants'. This may have influenced the character of the research. Secondly, since this was the first time pastoralists met with interviewers, they may have felt uneasy and therefore unwilling to divulge all the information they had to strangers. This partly explains why there were fewer species mentioned during the household survey than the other three survey methods (Table 2). It could also reflect the variation in knowledge between individual household heads.

Semi-structured interviews with key informants allowed natural conversation and eliminated the bias associated with structured questionnaires. The distinctive feature of this approach was the iterative and rigorous evaluation of knowledge as it was elicited and analyzed. Although iterative fieldwork proved efficient in getting detailed information that would not otherwise have been elicited using a structured questionnaire, it had its drawbacks. The repetitive cycles meant that the same informants had to be interviewed two to three times. The process of confirming knowledge and checking contradictions was at times irritating to informants who felt they were being repeatedly asked the same questions. This observation is consistent with the findings of Southern (1994), Jinadasa (1995), and Kiptot (1996) in their studies of farmers' ecological knowledge in Kandy district (Sri Lanka) and Machakos district (Kenya), respectively. It is difficult to see how this can be avoided, since it is imperative to confirm an informant's response is a true reflection of his intended meaning. A practical solution is to design knowledge acquisition strategies that restrict subject coverage so that in-depth knowledge can be obtained in at least some areas without burdening any individual informant.

The tree and shrub inventory was used to collect quantitative data on the number and kinds of plant species found in the rangelands. This exercise demonstrated the familiarity with which pastoralists identified species using local names. Physically seeing the trees and shrubs often reminded the informants of trees they had previously not mentioned. As a result, the inventory identified more fodder species than the household survey and informal interviews with key informants (Table 2).

Pastoralists identified trees and shrubs with great ease and confidence though it proved to be time consuming. The time invested in sampling the trees and shrubs, however, was worthwhile as the information obtained permitted a more thorough analysis of the ecological structure of the rangelands. It also provided an opportunity for the research team to collect plant specimens of species whose botanical names were unknown and those that had the same local names and yet were botanically different. The specimens collected were taken to the herbarium in Nairobi, Kenya, for identification.

The group consensus method demonstrated that no one informant is an expert. It also confirmed the validity and consistency of the indigenous knowledge that had been elicited earlier using the other three survey methods. During discussions, informants were free to supplement and question the knowledge elicited, and, as a result, the group consensus method furnished more knowledge on tree fodder resources than the individual interviews (Table 2). It also proved to be a cost-effective and time-efficient method of validating local knowledge and should be highly encouraged as it is quite commensurate with the practical limitations of time and travel often experienced by researchers seeking to validate knowledge with randomly selected informants from the general population.

Conclusion

This study has shown that there is much more to indigenous knowledge of tree fodder utilization than meets the eye and therefore research of this type requires the use of multiple methods in order to (1) capture detailed knowledge that would not otherwise be captured when one method is used; (2) ensure that all informants irrespective of their knowledge status participate; and (3) ensure the quality and accuracy of knowledge gathered, support its utility as a tool for natural resource management.

This study has also brought to the fore the underlying methodological challenges associated with identifying "the" most knowledgeable informants. The approach used here and used by many researchers in the past was subjective (Rusten and Gold, 1991; Den Biggelaar and Gold, 1995; Thapa et al., 1995). There is no guarantee that those interviewed were the "most knowledgeable," and the fact that the group consensus method generated more knowledge than deliberately selected informants (Table 2) suggests that researchers should not only rely on experts but also should use other methods to complement the knowledge obtained from the so-called knowledgeable informants.

Not much scientific research has been done on many of the fodder species identified by pastoralists. Apart from species in the genera *Acacia, Balanites*, and *Grewia*, very little scientific information is known about the other indigenous fodder species preferred by pastoralists. There is a great need for research to identify detailed, species-specific protocols on management to ensure maximum yields of leaf and pod production per tree per hectare, so pastoralists can make maximum use of these species. A detailed chemical assessment of prioritized fodder trees and shrubs should also be undertaken especially with regard to nutritive and anti-nutritive factors. Ironically, some of the species identified as good for fodder are toxic to livestock when immature pods/leaves are consumed in large quantities. Species known to cause toxicity such as *Acacia tortilis*, *Balanites agyptiaca*, *Commiphora africana, Balanites glabra*, and *Acacia nilotica* should be investigated so that pastoralists can be advised on how best to minimize the toxic effects on livestock. Such indigenous knowledge-based research, if undertaken, will definitely go a long way in improving the productivity of pastoral management systems.

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Notes

1. Indigenous knowledge is here defined as the culturally specific knowledge held by members of a culturally defined community.
2. The population of Kajiado increased rapidly from 85,903 in 1969 to 149,005 in 1979 and 500,000 in 1999 (Republic of Kenya, 2001). The population density, which has increased from 12 persons/km^2 to 24 persons/km^2, is largely attributed to the immigration of non-Maasai to Kajiado district (MOARD, 2001).
3. Other studies on tree fodder resources were undertaken by Bayer (1990), Walker et al. (1995), Morrison et al. (1996), Thapa et al. (1997) and Thorne et al. (1999).
4. Roothaert and Franzel (2001), in their study of farmers' preferences and use of local fodder trees and shrubs among the Aembu and the Mbeere people of eastern Kenya, used semi-structured interviews, formal individual interviews combined with tree inventory, and feedback group discussions. The bao game was used by key informants in ranking species. The study reported here, although it used similar methods, followed a different sequence of the methods. The approach of selecting key informants was also different and the informants used the pair-wise matrix ranking exercise.

5. Kenya is administratively divided into provinces, which are further sub-divided into districts, divisions, locations, sub-locations, and villages.
6. This is whereby questions about a topic under study are posed to a group of participants who are asked to discuss and come to a general agreement. For example in this study reported here, a list of species was presented to participants and were asked to discuss on whether the species are useful for fodder and were free to remove or add more species if they found the list not exhaustive.
7. Drought is a recurrent phenomenon in arid and semi-arid areas of East Africa. Rainfall results obtained from the International Livestock Research Institute as well as interviews with pastoralists indicate that drought recurs as frequently as every four years. When drought occurs, even the dry season grazing areas (hill-tops) are severely affected and cannot meet the pastoralists' requirements for browse.

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