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The Socio-Economics, Culture and Ecology of Bee-Keeping Among the Akamba Community of Southern Kenya

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INTRODUCTION

According to Crane (1979, 1990), Crane et al. (1984), IBRA (1976), Mann (1973) and Tecwyn (1976), bee-keeping enhancement in the rangelands serves several important purposes. These include the provision of extra non-perishable food products such as honey and wax, propolis and pollen (from which farmers could obtain cash income), and a means of pollination for agricultural, horticultural and tree crops, leading to better harvests from existing croplands.

Bee-keeping is particularly appropriate because it does not compete directly for resources with other agricultural activities; it requires little space (50 hives can be accommodated in a tenth of a hectare) and land can be of poor quality. Honey production can be done with little financial input; traditional hives are made from local materials, while colony maintenance and honey processing do not require any special equipment under traditional set-up. It is a flexible occupation, easily undertaken by people of both sexes, and it can be done on a full-time or part-time basis. Tsetse infested areas, which are not ideal for livestock production but have diverse vegetation species, can also be a good source of honey flow. Honey production requires little investment but provides employment, food and foreign exchange. It is a major source of income for rural households, especially in the dry areas (Ngethe, 1985).

Despite all this, studies have shown that honey production in the arid and semi-arid lands (ASALs) or rangelands of Kenya is lower than it was two decades ago. In the past, honey production has been a major industry in Ukambani. Many years ago, it was a vital factor in the Akamba culture and was used in many ways as an article of trade. Gifts of honey and honeybeer featured largely in dowries presented to parents of a bride-to-be. Large quantities of honey used to be acquired by traders in Ukambani but are not easily available today (Nightingale, 1976). It is, however, possible to reverse this trend given the necessary research and development efforts.

Honey production could be a major industry among the Akamba community but has not been fully exploited. The amount of crude honey produced could be increased from the current 9,200kg to over 100,000kg in Makueni District of southern Kenya, which the community inhabits (GoK, 1993). In view of the need to increase household incomes, employment and food production among the Akamba, a study was designed to determine the factors that limit honey production. It is already established that there are four important requirements for successful bee-keeping. One is climate and plant conditions that lead to the availability of nectar and pollen resources. The second is well-adapted, industrious and manageable bees. The third is familiarity and skill of the population in the management of colonies. And finally is sufficient market opportunities for the main bee products – honey and wax (Drescher and Crane, 1982).

The principal objective of this study was to document the most important factors that influence honey production and the situation existing in the study area – Kibwezi Division of Makueni District, Kenya. The specific objectives were to:

- retrieve and document the local knowledge on bee management of the Akamba community;
- determine major honey plants in the study area; and
- identify the honeybee races or varieties found in the area.

It was hypothesised that, in the study area, land-use conflicts adversely affect honey production, the honey produced is multi-floral, and several types of bee races or varieties produce the honey.

THE BIO-PHYSICAL ENVIRONMENT OF THE STUDY AREA

The study area (Kibwezi Division) is

situated about 200km to the south-east of Nairobi. Its altitude varies from 600m to 1,100m. It lies between 2°6'S and 3°S latitude and 37°36'E and 38°30'E longitude respectively. Because of its low agricultural potential and heavy infestation of tsetse flies, the area was not inhabited until the 1930s. Kibwezi Division covers 47% of Makueni District and has a total area of 3,400km² (CBS, 1981, 1986). It has five locations – Makindu, Kikumbulyu, Ngwata, Masongaleni and Mtito Andei. The area lies in agro-climatic zone V (Braun, 1977; Pratt and Gwynne, 1977). It is characterised by low and unreliable rainfall, marginal agricultural land, dispersed population, and low soil fertility. The average annual rainfall and temperature are 600mm and 23°C respectively (Michieka and Van der Pouw, 1977; Braun, 1977). Rainfall is bimodal; long rains are received in March to May and short rains in November to December or early January. Short rains are more reliable than long rains.

Vegetation distribution in the area is controlled by a number of complex and interrelated factors, such as climate, geological formation, soil type and the presence or absence of ground water (Baker, 1954; Saggerson, 1963; Gachimbi, 1990). The area is a typical semi-arid rangeland, dominated by *Commiphora, Acacia* and allied genera, many of shrubby habit. Baobab trees (*Adansonia digitata*) are common. Perennial grasses such as *Cenchrus ciliaris* and *Chroris roxburghiana* can dominate but they succumb to continuous abuse over a long period (Pratt and Gwynne, 1977; Touber, 1983). Man, through cutting trees, clearing, burning, and grazing, is the most important factor that has modified the original vegetation (Tiffen, 1991).

The largest ethnic group in the study area is the Akamba. As in the pre-colonial times, they depend in part on pastoral and part agronomic economy to meet most of their needs (Mbithi and Barnes, 1975). Most production systems include cultivated plots and access to communal grazing lands. Other activities are bee-keeping, sand harvesting and charcoal making. The Akamba also keep livestock, composed of cattle, sheep and goats. Rabbits and poultry are also kept. Mbinda (1992) found that a vast majority of farmers (97%) kept poultry, a few (9%) kept donkeys for transport and about 35% kept beehives, constructed from hollowed-out logs. Honey is used for home consumption, as an ingredient for locally brewed beer, or sold. Farming is minimally undertaken, with Katumani maize, pigeon peas and sorghum as the major crops. Small-scale irrigation of horticultural crops is carried out in some parts of the study area (GoK, 1993).

Estimates of the human population indicate that in 1996 there were 166,046 persons in the study area, making a density of 49 people/km² (GoK, 1993). This is a high figure for this area, which is of low agricultural potential. The main problems here are lack of water, capital and labour to make land productive. The population structure is made up of 50% young people (0-14 years) and 5.2% of the population above 59 years.

MATERIALS AND METHODS

Socio-Economic Approaches

Data on factors affecting honey production and the indigenous knowledge of the Akamba community on honey production were collected from the bee-keepers, Community Development Assistants (CDAs), Divisional Livestock Production Officers, local NGOs and local honey collection centres, using formal and informal interviews by a questionnaire. Simple random sampling was adopted to choose the bee-keepers to be interviewed. Since it was difficult to establish the number of bee-keepers in the study area, those to be interviewed were selected randomly along the Kibwezi-Athi and Kisayani-Masongaleni roads. Additional bee-keepers were selected outside Kikumbulyu Location where most of the survey was concentrated. A total of 53 bee-keepers were interviewed. Informal interviews with those who did not keep bees were also done. The questionnaire approach as described by Weisberg and Bowen (1977) and Drescher and Crane (1982) was used to collect data relevant to this part of the study.

Ecological Information

Vegetation Survey and Analysis: Vegetation composition of settled and unsettled areas was

done and comparisons made to determine whether significant differences existed between them. Plant attributes such as density, frequency, per cent species botanical composition, and similarity and diversity indices were analysed. This involved recording the number of species in the unsettled area within the University of Nairobi Dryland Field Station and the adjacent settled Kasemeini area.

Vegetation survey was done by 'plot method,' except for the baobab where the 'closest individual method' was used due to the plant's infrequent occurrence. Eighteen plots of 10m x 10m in size were used in total for each site and were randomly distributed in a stretch of 10km transect. For plant density comparison, four transects were selected at random for the two sites, along Kisayani-Kyanginywa road, measuring between 1.5 and 2.5km. Species diversity was analysed by use of Shannon-Weiner Index (see Mueller-Dumbois and Ellenberg, 1974), while community similarity was done by the Sorensen's Coefficient approach (see Sorensen, 1948).

Determination of Honey Plants: In this study, microscopic analysis, field observations and indigenous knowledge were used. Microscopic analysis was carried out as described by Vorwohl (1976), Moore et al. (1991) and Kahenya and Gathuru (1985).

Determination of Honeybee Varieties: Morphometric methods as used by Ruttner (1975) were applied to identify honeybee races and or varieties. Five samples of bees were collected, one from each location in the study area. Ten bees from each sample were randomly selected and ten morphometric characteristics measured. These were hind-leg length, hind- and fore-wing length, femur length, colour of tergite 1-3, hind- and fore-wing width, colour of sternite 1-3, colour of head and thorax, and body size and shape.

Statistical Analysis

The study design adopted was the 'completely randomised design' (CRD) as described by Steel and Torrie (1980). 'One way analysis of variance' (ANOVA) was conducted on botanical species composition and density of woody vegetation to compare the two sites (see Steel and Torrie, 1980; Gomez and Gomez, 1984). Socio-economic data, collected using a questionnaire, were summarised and where appropriate analysed by use of ANOVA and regressions.

RESULTS AND DISCUSSIONS

Factors Affecting Honey Production

Several factors affect honey production in the study area. They include land-use conflicts, lack of forage, socio-cultural factors, lack of equipment, inadequate knowledge on honey production, bee behaviour, predators, and pests. Others include poor marketing and transportation systems, inadequate training and extension services, inefficient institutional structures, lack of credit facilities, inadequate labour, and unfavourable climatic factors. These factors can be classified as socio-ecological, socio-cultural and socio-economic.

Socio-Ecological Factors: Socio-ecological factors such as land-use conflict, lack of forage, bee behaviour, predators and pests, and unfavourable climatic factors are the main impediments to bee-keeping. Most of the land (>70%) with good bee forage has been cleared for various purposes, such as food and horticultural crop production, and wood for construction, fencing and charcoal burning. This indiscriminate cutting of vegetation has removed important nectar and pollen producing plant species and nesting sites for honeybees.

An average household owns about 6.5ha of land, which is small compared to the number of colonies that ranged from 3–500. A variation of 19.36% in the number of colonies was accounted for by a linear function of land size. It was also shown that for every unit change in land size the number of colonies was expected to increase by 2.13 units.

Honeybees in the study area are aggressive when the hive is full of honey or empty, the colony is brooding or is disturbed during harvesting, and when the bees harvest nectar and pollen from certain plants (such as *Ipomoea kituensis*). This problem is compounded by lack of protective clothing. As a result, 20% of potential honey is lost and its quality is affected as harvesting is done hurriedly.

Migratory and reproductive swarming, which is the departure of some of the bees from a colony,

occurs when the colony is big and food is inadequate. This takes place between January and March. Absconding, which is the departure of all bees from a hive, is caused by the presence of pests and predators, unfavourable weather conditions, scarcity of food and water, and unsuitable hive size. Absconding occurs between July and September. The non-occupancy of hives was estimated at 30-40% at this time of the year.

Honey badgers were reported by 80% of bee-keepers as having damaged 30% of their colonies. They are controlled by hanging the hive using wires or hooks, special traps, thorny branches at the base of the tree apiary, and by placing a metallic sheet around the tree. Caterpillars were found to attack buds and flowers of plants that are major sources of honey and can reduce honey and beeswax production by 80%. No control measure was in place. Other predators such as birds, squirrels, snakes, ants and monkeys are a problem and occasionally lead to absconding.

Introduction of horticultural crops in the study area has led to an increase in honeybee poisoning by pesticides. It was reported that 40% of bee-keepers had noticed dead bees in their colonies, which could have been caused by either bee poisoning or diseases. Bush fires that are either accidental or intentional were reported too to have destroyed many colonies. Unfavourable climatic conditions, such as high temperatures, low rainfall, and high wind speed and direction have also reduced honey production. They lead to inadequate bee forage and hence absconding.

Socio-Economic and Cultural Factors: Socio-cultural factors such as certain beliefs, age of farmer and vandalism influence the levels of honey production. Bee-keeping in the study area is traditional in nature and is mainly old peoples' business; most of the bee-keepers (80%) are over 40 years old. Vandalism is responsible for the destruction of tractable strains of bees and the survival of the fierce ones. In olden days, this used to be counteracted by use of witchcraft or charms (locally, *Mbingo*); but this is not applicable nowadays!

Lack of modern hives, honey and beeswax harvesting and processing equipment, and knowledge on appropriate honey harvesting stages, poor marketing and infrastructure, and inadequate labour have also adversely affected honey production. Among the bee-keepers interviewed, only 13.2% had used modern hives and supportive equipment. Unfortunately, these hives were found to be unsuitable for the area due to unfavourable weather conditions. Lack of honey harvesting and storage equipment was reported by 80% of the respondents. Unavailability of modern honey extractors and beeswax processing equipment was also affecting bee-keeping. Processing is mainly done using traditional methods of smashing, straining, squeezing, draining and heating, which affect honey and beeswax quality and quantity.

Lack of knowledge on the appropriate honey harvesting stage is a serious problem too. Harvesting too early results in removing unripe honey with high water content that ferments easily. Starting to harvest too late, on the other hand, leads to a loss of honey because of engorgement by bees preparing for seasonal migratory swarming. Traditional harvesting indicators were in use.

Honey is valued mostly for its socio-cultural uses and the level of production has no bearing on its market value. A kilogram of honey is sold at KShs 47.00 (just more than US$ 0.5) at the farmgate level. The main buyers are the local brewers, shopkeepers, local consumers, local co-operatives and middlemen from within and without the community. Lack of market information on prices and reliable buyers was noted. Poor infrastructure and transport to collect honey and beeswax greatly reduce the quantities reaching the market.

Inadequate training and extension services contribute to the low level of honey production. This is reflected in the fact that only 5.2% of the bee-keepers interviewed had some training in modern bee-keeping. Institutional structures and credit facilities to support honey production are lacking, as 90% of the bee-keepers use household labour, with only 3.7% affording hired labour. As reported by 80% of the respondents, household labour is provided by the old, who are weak. This affects production because most of the hives end up not being placed.

Indigenous Bee Management Knowledge, Beliefs and Skills

The Akamba community has been known to

be one of the most progressive and knowledgeable in many aspects of honey production. They know such things as the difference between queens, drones, and workers. History has it that a group of people called the *Ngulia* inhabited the area and their main diet was honey, milk and animal flesh. They were honey hunters, and harvested honey from different bees' caves: tree caves, underground holes, and stone caves. Honey production was traditional in nature and several cultural beliefs were associated with it. Then, it was exclusively a male activity. Women were not allowed to come near apiaries or hives when they were experiencing their monthly periods for this was believed to cause absconding. Men were not allowed to have sexual relationship until a day after harvesting to prevent absconding. Men exclusively used some hive products. But now both sexes are participating in all these ways.

The Akamba are well versed in a number of bee-keeping management aspects, ranging from hive making and placement, honey harvesting and processing, honeybee classification, and making bee-keeping equipment. Honey and other hive products and bees had several uses in the society.

Hive Making and Placement: The Akamba people were found to be skilled in hive making and placement. Trees that are a good source of nectar and pollen, such as *Commiphora baluensis, Terminalia brownii, Melia volkensii* and *Lannea stuhlmannii*, were selected for both hive making and placement. Hives were scented using propolis and shrubs such as *Ocimum basilicum* to make them attractive to the bees for quick occupation before placement. After hive placement and occupation, little management was needed until harvesting.

Honey Harvesting and Processing: Honey harvesting is done mainly between January to March and June to July. It is usually done late in the evening because most of the African bees are fierce during the day. Traditional harvesting equipment is mainly used. After harvesting, the Akamba process their honey. Traditional methods of smashing and scooping, squeezing by hand, and heating are used.

Uses of Bees, Honey and other Hive Products: The local community in the study area uses honey as food by eating it directly or by making various cereal flours and meat stews. Honey is also used for making local brew (which is important in social functions), as medicine for gastritis and sore throat, in marriage rites for dowry payment, in sacrifices to gods and forefathers, in purification ceremonies, as a means of barter trade, and as a source of income.

Honeycombs are used in making wax, local brew, medicines for sore throat, and in scenting new hives. Pollen is used in local brew and is a source of protein, while propolis is used for scenting new hives, as medicine, for repairing utensils and household goods, and for purification of the local brew. Brood is used in local brew and as food.

In the days past, bees were sacred in the Akamba community and were used in many ways. They were a symbol to the society for when it was to rain and they foretold the future. Swarming by the month of August signified the arrival of rains, while swarming towards the west told of coming drought. They were associated with philosophy and eloquence, and had magical or religious significance. They implied good fate.

Bee-Keeping Equipment: Modern bee-keeping equipment, although known, is not in use in the study area; bee-keepers use traditional equipment. This equipment can be classified into:

- hive making and placement equipment, which includes an axe, machete, chisel, wooden pegs and mallet; and
- honey harvesting and storage equipment that includes a knife, wooden smoker (usually made of *Melia volkensii* and *Euphorbia tilucali*), skin drum, plastic pail, rope, metal tin and skin bag.

Honey Vegetation

Honey Plants and their Flowering Phenology: Some of the abundant honey plants, with their scientific and local names, and flowering phenology are given in table 1. The most important phenological feature of the plants in the table is that flowering occurs all year round; there is at least one plant species flowering in each month of the year. This is important for honey producers and policy makers because honey supply can be planned to cover all the 12 months of the year, albeit with differing quality and

quantity because of the varied plant species. In addition to ensuring stable income generation for households from bee products, this would encourage conservation of a wide array of plants, thus contributing to bio-diversity conservation and, in turn, general environmental stability.

Shrubs were the most dominant, forming 64.7% of the species, followed by trees (35.3%). A comparison of settled and unsettled sites showed that tree density is on the decline while that of shrubs on the increase. Shrubs were the most dominant in the two sites. A comparison of density and relative frequency of similar species showed that the species with a higher density have also a higher relative frequency, with a few exceptions. This shows that dispersion is uniform. The unsettled and settled areas had a diversity index of 1.28 and 1.36 respectively, which were not significantly different. The similarity index was 52.17% while the dissimilarity

Table 1: Flowering phenology (months) of major honey plants in the study area based on field observations and local knowledge

Species name	*Akamba/Common name*	*Flowering phenology*
Acacia drepanolobium	Kiunga	March
Acacia gerrardii	Munina/Musemei	March
Acacia mellifera	Kithiia	March, September
Acacia nilotica	Musemei	March
Acacia senegal	Kikunya mbiti	March, September
Acacia seyal	Mukela	March, September
Acacia tortilis	Mwaa	March, June, September
Acacia xanthophloea	Musewa	March
Acanthospermum hirsuta	Ikongo	March
Adansonia digitata	Muamba/Baobab	November
Agave sisalana	Ikonge/Sisal	April, May
Albizia antihelminthica	Kyoa/Muoa/Muowa	September
Balanites aegyptiaca	Kitului	September, October
Boscia coreaceae	Kisivu	September
Cajanus cajan	Nzuu/Pigeon peas	June
Cassia siamea	Ikengeta	February
Chrolis myroistachyus	Kilili	February
Combretum apiculatum	Dja/Kiama	November
Combretum hexalatum	Mukokola	November
Combretum molle	Kiama	November
Commiphora africana	Kitungu/Mutungu	March, September, October
Commiphora baluensis	Itula	March, October
Commiphora boviniana	Kyoa	October
Commiphora campestris	Iulu	October
Cynodon dactylon	Ikoka	April
Eragrostis Superba	Mweetwa	February
Euphorbia tilucali	Ndau	September
Euphorbia candelabrum	Kyaa/Kyulungu	September
Grewia bicolor	Ilawa	January, April, November, December
Grewia villosa	Kivu	January, April, November, December
Indigofera spp.	Msuusu	May, June
Ipomoea kituensis	Kiungu	January, April, June, July
Ipomoea mombassana	Ivau	July
Lantana camara	Mutavisi	January, April, May
Lantana spp.	Muti	January
Mangifera indica	Maembe/Mango	September
Manihot esculenta	Manga/Cassava	June
Melia volkensii	Mukau	August, September
Phaseolus vulgaris	Mboso/Beans	December
Sida ovata	Uvyaio	December
Solanum incunum	Ngondu/Soddom apple	May, June
Sterculia africana	Ikui/Kyusya	August
Sterculia rhinicocarpa	Kyusya	September
Tamarindas indica	Muthumula/Mukwasu	October
Terminalia brownii	Kuuku/Muvuku	October
Zea mays	Mbemba/Maize	February, May, December

index was 47.83%.

Clearing land for cultivation, cutting trees (for fencing, hive making, charcoal burning and fuel wood), and continuous browsing pressure by both wildlife and livestock were some of the factors contributing to the lower density of trees in the settled area than in the unsettled one.

High and similar species diversity is an indication that both sites have complex plant communities, since a greater variety of species allows for greater species interactions. A high similarity index indicates that the two plant communities are weakly associated and may have similar floristic composition.

If we assume that plant attributes are correlated with the amount of bee forage that bees can harvest in space and time, then the higher the attributes the higher the honey production. It can be concluded therefore that the unsettled site with a higher plant density per hectare has the potential to have higher honey production per hectare than the settled site, considering that diversity, frequency and plant species are similar in the two sites. If the availability and acceptability of forage to the bees is considered, this conclusion may not always hold. Further research is, therefore, needed to establish whether plant attributes have any relationship with honey production. Considering that frequency, diversity and plant species are similar in the two sites, conservation and proper management of the already existing plant resources in the settled areas can lead to an increase in honey production with time.

The density of the common baobab (*Adansonia digitata*) was determined and the mean number of plants per hectare found to be the same in both settled and virgin areas. Baobabs are large and huge perennial plants. This makes it difficult to cut them for fencing materials, hive making, charcoal burning, fuel wood and during clearing for cultivation, unlike other vegetation. Furthermore, the plant is not a good source of charcoal and fuel wood. Coupled with its high socio-economic regards in the Akamba community, this explains why its density is similar in the two sites. The plant is important to bee-keepers, however, for it helps prevent attacks of colonies by predators, like honey badgers and human beings. The tree, which has a smooth and slippery bark, is tall and almost branch-less. It is, therefore, invaluable for hive placement. It is a major honey flow resource in the month of November when it flowers.

Apart from its importance in honey production, the baobab is a tree that could be extensively exploited for its multiple-use benefits. It can be used for fodder production, as a vegetable, for ornamental purposes, for soil conservation, as medicine, and for threads in making traditional baskets. Its fruits are nutritious and can be used as food when consumed directly, and are a source of vitamin C. The plant is also used as an indicator of the onset of rainfall; it produces its leaves just before the onset of rains. Its hollow trunk acts as a water storage facility during the dry season, and serves as a house, storage barn, and even a place for refuge from marauding animals. Its bark is a good source of dyes. Therefore the conservation of the tree for honey production serves other multiple-uses.

Pollen Analysis of Important Honey Plants: Microscopic analysis, field observations and indigenous technical knowledge of major honey plants showed that honey in the study area is multi-floral (Table 2). This is not surprising considering the high species diversity in the ecosystem. At least 32 plant families and 187 plant species were identified in the study area, of which 20 families were found to be useful for honey production.

Identification of Honeybee Races/Varieties

The Akamba community traditionally classified honeybees according to the pattern of comb-building on the hive and various morphological and behavioural characteristics, such as size, colour, temperament, and productivity. Classification was also based on the ecology of the bees and the clans of bee-keepers; it was believed that each clan had its own bees. The various classifications were based on:

- the habitat of bees – cave bees and hive bees;
- colour, size, aggressiveness and productivity – for example, locally, *Saki* (black, small, more aggressive and more productive) and *Syondumwa* (yellow, large, docile, less productive and always brooding); and
- comb-construction – crossword arrangement, length-wise arrangement (more productive), and diagonal arrangement (less productive).

Table 2: Analysis of pollen in honey in the study area based on plant families (percentages in brackets)

Plant family: genus[a]	*Sample 1*	*Sample 2*	*Sample 3*	*Sample 4*	*Mean (%)*
Acathaceae: *Blepharis,Justicia, Peristrophea*		12(3.13)			0.78
Amaranthaceae: *Aeva, others*	2(4.08)	15(3.92)	17(2.51)	10(11.90)	5.60
Anarcardiaceae: Lannea, Haevie	58(15.14)	20(2.95)			4.52
Balanitaceae: *Balanites*		5(1.31)			0.33
Boraginaceae: *Heliotropium, Cordia*		7(1.31)			0.46
Bursevarietyae: *Commiphora*		38(9.92)	23(3.40)		3.33
Capparidaceae: *Boscia, Maerua*		13(3.39)	62(9.16)	3(3.57)	4.03
Celastvarietyae: *Maytenus, Hippocrate*				3(3.57)	0.89
Combretaceae:*Terminalia, Combretum*	35(71.43)	16(4.18)	62(9.16)	12(14.30)	24.77
Compositae	2(4.08)	128(33.42)	324(47.90)	12(14.30)	24.92
Convolvulaceae: *Hildebrandtia*				2(2.38)	0.60
Cucurbitaceae: *Lufta, Cucumis**	Large	7(1.83)	9(1.33)		0.79
Euphorbiaceae: *Jatropha*		8(2.09)		13(15.50)	4.40
Gramineae		9(2.35)	15(2.22)	3(3.57)	2.04
Labiatae: *Ocimum, Leucas*		3(0.78)			0.20
Loranthaceae: *Tapinanthus*				6(7.14)	1.79
Malvaceae	5(10.20)			30(4.43)	3.66
Mimosaceae: *Acacia, Albizia, Dichrostachys*	5(10.20)	56(14.62)	115(16.99)	20(23.84)	6.40
Papilionaceae: Indigofera		2(0.78)			0.20
Salvadovarietyae :*Salvadora**					Large
Unknown			30(4.38)		0.33
Total	49(100)	383(100)	702(100)	84(100)	100

[a]Harvesting time: Sample 1, January; Sample 2, January–February; Sample 3, February–July; Sample 4, August.
*Plant families were excluded in the calculation of per cent total pollen grains in the respective samples. Note also that the percentages may not total to 100 because of rounding off.

Three varieties of honeybees exist in the study area. Their characteristics are summarised in table 3.

A comparison of the results with the findings of Smith (1961), Tonapi (1980), Ruttner (1975), Ruttner and Kauhasen (1985), Drescher and Crane (1982), Crane (1990) and Mbaya (1985) indicate that the honeybee varieties I, II, and III are *Apis mellifera litorea, Apis mellifera scutellata* and *Apis mellifera monticola* respectively. Among the bees sampled, 34 (67.6%) were of variety I, 14 (27%) variety II and 2 (5.4%) variety III. This shows that *Apis mellifera litorea* dominates in the region. Since different varieties of honeybees exist in space and time, bee-keeping management should be geared towards each of them for higher honey production.

CONCLUSIONS AND RECOMMENDATIONS

Several variables are responsible for low quality and quantity honey in southern Kenya. They include ecological, cultural, and socio-economic factors. The Akamba community is knowledgeable in many aspects of honey production, and hive products have different uses in the society. Honey production is multi-floral and various factors affect this flow resource, the major one being land-use conflicts. Three

Table 3: Characteristics of honeybee varieties identified in the study area

Characteristics	*Variety I*	*Variety II*	*Variety III*
Head and Thorax	Dark	Dark	Dark
1,2,3 tergites & sternites	Golden yellow, rest dark	Abdomen intense yellow	1,2 dark yellow, rest dark
Hind leg length (mm)	7.1	7.5	8.0
Femur length (mm)	3.0	3.3	4.0
Forewing length (mm)	8.3	8.5	9.0
Hindwing length (mm)	5.0	5.5	6.0
Forewing width (mm)	2.6	3.0	3.1
Hind wing width (mm)	1.9	2.0	2.1
Body size (mm)	10.0 (Small)	12.5 (Medium)	13.0 (Long)
Body shape	Slender	Medium slender	Broad

varieties of honeybees are found in the area. Thus, management activities should be geared toward each of them for increased honey production.

The present concern about food shortages, unemployment and the much-needed foreign exchange in Kenya has stimulated attempts to increase honey production. However, the production and processing of honey in the southern rangelands of the country have been stagnant. These dry areas may not be able to sustain more colonies than the current number, and to achieve this objective it is recommended that:

- more research be undertaken to determine the maximum colony capacity of different ecological zones in the region. Such information will be useful to farmers who plan to keep many colonies in the area;
- revival of existing honey refineries and collection centres and creation of new ones be encouraged to cater for honey producers;
- informed technical support be provided in close liaison with government departments to advise bee-keepers on methods that would help to resolve the problems affecting honey production and improve on traditional methods;
- research on suitable hives and supportive equipment for use in the rangelands be initiated, rather than advocating for the replacement of all traditional hives with modern hives without considering their suitability in this region;
- active research is initiated to provide continuous information on bee-plant interactions;
- a statutory honey and hive products authority be formed to co-ordinate and regulate bee-keeping in the rangelands. Such an authority could also take over the processing and marketing of honey and other hive products;
- selection, documentation, promotion and maintenance of a gene bank of appropriate woody plants that provide large amounts of nectar and or pollen for bees be done;
- local technical knowledge on honey production must be tapped if a successful transition from traditional to modern bee-keeping is to be achieved;
- samples of honey should be taken regularly in order to obtain proper and more detailed results from pollen analysis; and
- appropriate legislation to protect bee-keepers from vandalism, as is the case in countries like Britain and USA (Crane, 1990) should be put in place.

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KEYWORDS Bee-keeping. Akamba Community. Indigenous Knowledge. Bio-diversity. Semi-arid Kenya.

ABSTRACT This study, carried out among the Akamba community inhabiting semi-arid country in southern Kenya, investigated the factors affecting honey production. It was found that the size of landholdings explains up to 20% of the variation in the distribution of beehives among bee-keepers. In addition, land-use shift from livestock rearing under bush-land to cultivation has negatively impacted honey production through indiscriminate cutting of trees, which has led to the destruction of honey plants. In the recent past, bee-keeping and honey production have been on the decline because of the advent of horticultural and dryland farming, increased use of pesticides, deforestation, and degradation of the environment. Farming activities, increased construction of houses due to rising population, charcoal burning, and fencing have, in sum, reduced the proportion of nectar-producing plant species. Although the local people have a lot of traditional knowledge in bee-keeping, this has not been translated into increased production, commensurate with rising demand for honey. Among the above-mentioned factors, the reasons for this have been lack of incentives and extension services. This study recommends renewed efforts, therefore, by government and other development agents to undertake research and development activities geared towards boosting the number of apiaries, processing, and marketing to ensure sustainable honey production.

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