Local knowledge of biodiversity and ecosystem services in smallholder coffee farms in Central Province, Kenya

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Abstract

Research was carried out in two districts of the Central Province of Kenya during the period of June–August 2007; the main purpose of this research was to collate coffee farmers' knowledge about their farming practices and how they impact upon the environment – primarily concerning biodiversity. Semi-structured and depth interviews were held on interviewee farms and feedback sessions were held towards the completion of the fieldwork period. The methods used were successful in eliciting individual and group knowledge and opinions of coffee farming and the wider environment. The main issues that came through from the research were the heavy impacts of low coffee income on production and the resultant effects on biodiversity within coffee plots. There was also a need expressed for increased communication along the coffee chain, so that farmers could produce what the market wants while receiving a fair price. Coffee was only one of many crops grown on the smallholder farms visited, meaning that when looking at biodiversity and ecosystem services it was also important to assess them at farm level and landscape level.

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Chapter 1: Introduction

1.1 Background to coffee production in Kenya

Since the introduction of Arabica coffee (*Coffea arabica*) to Kenya in the early 1900s (Waters, 1972; Wild, 2004), the East African country has become a major exporter of the stimulant/beverage to the wider world (predominantly Europe and North America according to ICO statistics (2007a)). However, prices have fallen in recent years[1] with resultant impacts on coffee farmers and their ability to support themselves and their families. Fallen prices have been attributed to an imbalance of demand and supply, with coffee production in Kenya increasing on average by 3.6% per year whilst demand for coffee increases by only 1.5% per year – thus creating a surplus (ICO, 2007a; Karanja and Nyoro, 2002). Another reason given for low prices is the liberalisation of coffee since the collapse of the International Coffee Agreement in 1989 (Ponte, 2002). The Kenyan share of global coffee production has decreased from 1.29 per cent in 1999 to 0.9 per cent in 2006 and exports have declined to the point that horticulture, tourism and tea have overtaken it as a major foreign exchange earner (Agricultural Review, 2007).

A strategy to try and resolve some of the issues within coffee production has been to 'add value' through certification schemes that promote 'environmentally friendly' farming practices and/or fairer prices for the farmer; this has been widespread throughout coffee producing countries, but has not yet taken a strong hold in Kenya (Karanja and Nyoro, 2002; Ponte, 2004).

This research project was supported by CAFNET, a four-year project that hopes to make some positive changes to how the coffee process chain operates in order to improve coffee farmer income. A major concern of the project is ecosystem services and how coffee farming practices can benefit the environment as well as the farmer. According to CAFNET[2] (unpub.) coffee production sustains approximately

[1] *See* Appendix 1.
[2] CAFNET's aims are: 'connecting, enhancing and sustaining environmental services and market values of coffee agroforestry in Central America, East Africa and India' (CAFNET, unpub., Annex 1).

1,200,000 farmers in East Africa; indicating that any development towards more sustainable means of production could potentially affect many thousands of farmers as well as those indirectly affected by the coffee trade. It has been said that approximately 125 million people across Africa, Asia and Latin America depend on coffee for their livelihoods and it is the second most valuable export commodity after petroleum (Lashermes and Anthony, 2007; Osorio, 2002).

In Kenya, 60 per cent of coffee is produced by smallholders, who belong to cooperative societies, and the other 40 per cent by large estates (Nyambo *et al*., 1996; Ponte, 2002). Smallholder coffee is reputed to be of higher quality than that of the estates because of the way it is processed, yet, the price the farmer receives often does not reflect the quality of the coffee (ibid.). This is ultimately because of how the coffee chain works in Kenya, whereby each link of the chain adds value to the product until it is far above the initial value given to the producer (Ponte, 2002). The end link becomes so disconnected from the first that the smallholder farmer does not understand what happened in the middle and why s/he did not get any of the profit.

During interviews there were often references to 'middle men' and 'cartel' to explain the lack of money ending up with the coffee farmers. Effective communication has evidently been lacking and education about the coffee market does not seem to have reached the farmers. The farmer receives whatever price is given to the cooperative from the miller selling the coffee at the auction; from the auction, the buyer goes onto add the most value and bears no responsibility to the farmer (Figure 1.1).

An adverse effect of the 'coffee crisis' in terms of the environment has been a tendency for smallholder farmers to neglect their coffee crops or uproot them to make room for something more profitable (CAFNET, unpub.; ICO, 2007a; Kananja and Nyoro, 2002; Nyambo *et al*., 1996). There is a concern that destruction of the perennial tree-crop, however, can result in degradation of land and habitat for wildlife (CAFNET, unpub.; ICO, 2007b). For the CAFNET project to move onto the

next steps of what it wants to achieve with farmers, research into what farmers know and understand about their farming practices and the wider environment was required.

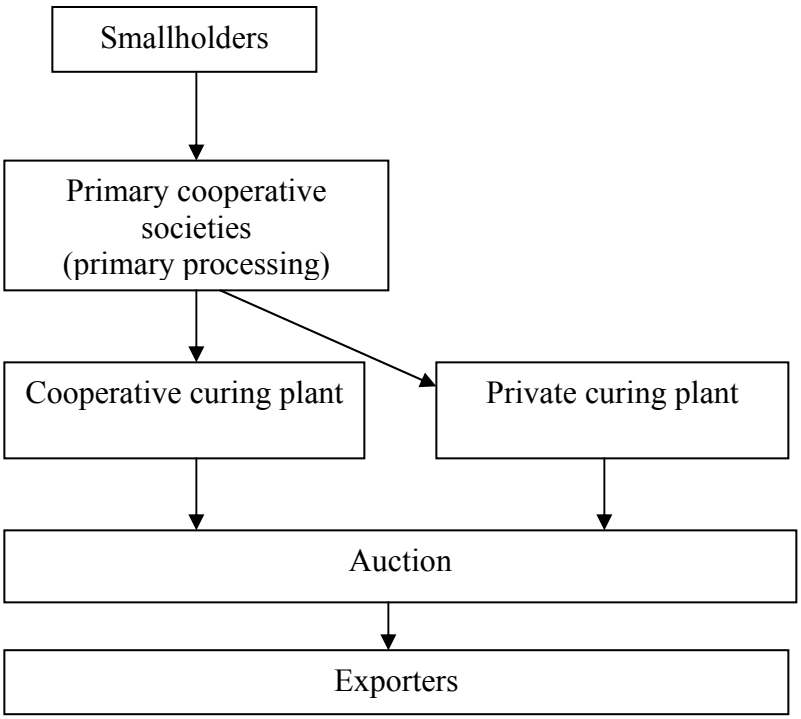

Figure 1.1. Post-liberalisation and current coffee-marketing chain (adapted from Ponte, 2002: 263).

1.2 Research location

1.2.1 Central Province

Central Province is made up of seven districts, which are divided into divisions, locations and sub-locations. Two of these districts were the focus of the project (Nyeri and Murang'a) and the main ethnic group in both areas was Kikuyu[3]. The major languages spoken were Swahili, Kikuyu and English. The areas were densely populated (Tables 1.1 and 1.2) with few major towns; agriculture was the main means of livelihood, with most families involved in farming small patches of land for subsistence foods and selling at markets (National Co-ordination Agency for Population and Development, 2005). Although farming was of great importance,

[3] Central Province is often called Kikuyu Land because of the tribe's dominance in the region.

families did not rely on just agriculture to support themselves (ibid.): there were usually at least one or two family members working in small businesses (e.g. phone credit kiosks, taxi driving, clothing stalls) either in local towns or Nairobi city.

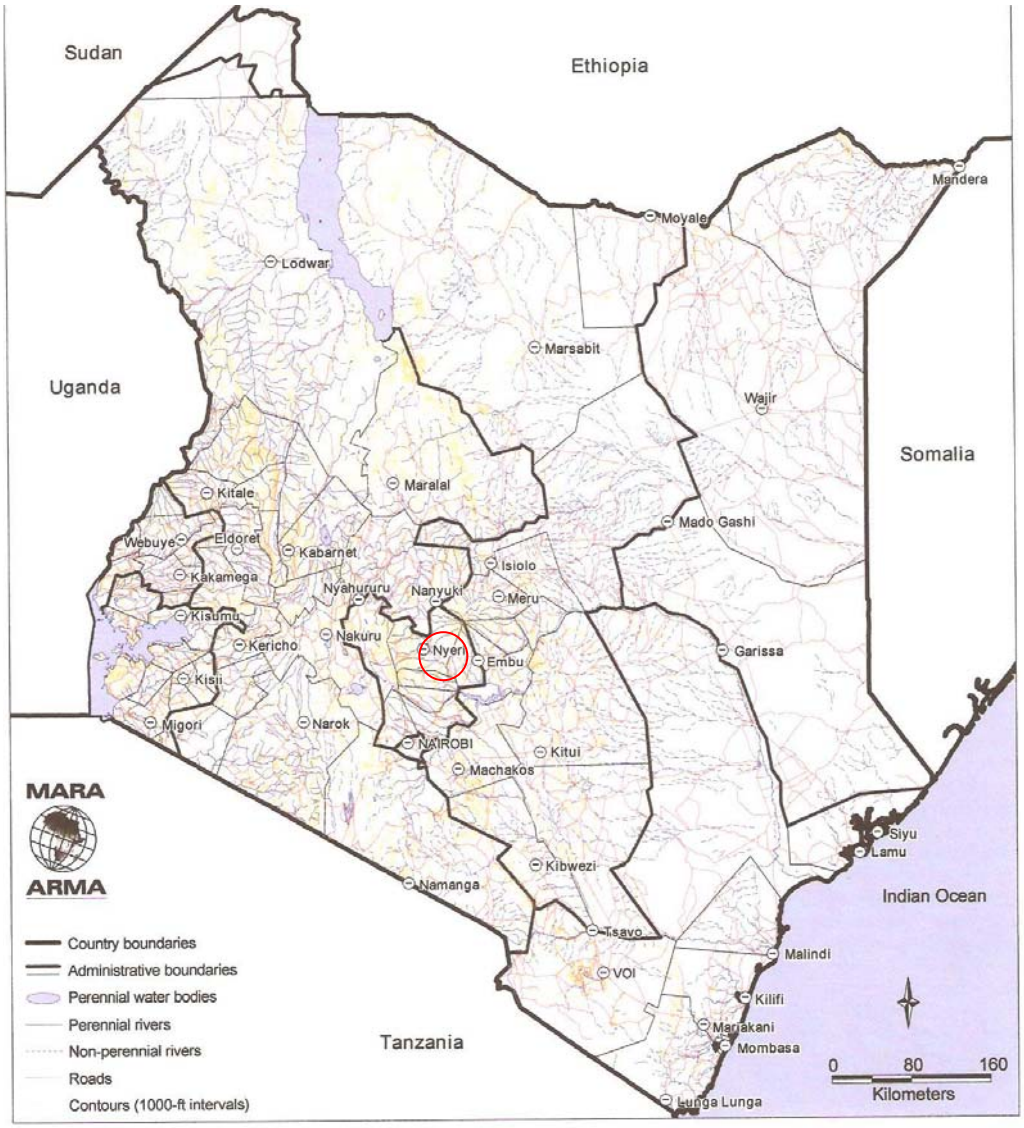

Figure 1.1. Kenya and its neighbouring countries in Eastern Africa, with the research area circled in red. Source: *http://www.mara.org.za*.

Murang'a District and Nyeri District were chosen as research areas because of their high densities of smallholder coffee farms and the comparative and common

practices that such an amount of coffee farmers could offer. The coffee grown on visited farms were Arabica varieties that were said to grow well at high altitude and farmers identified them as SL28, SL34, Blue Mountain and Ruiru 11. Within the study areas in the two Districts (Figure 1.2), the altitudinal range was 1600 m to 1880 m.

Table 1.1. Showing the administrative units, population size and density of Murang'a District, Central Province. Research areas are highlighted in red. Source: District's Statistics Office, Muranga, 2001 (cited in National Co-ordination Agency for Population and Development, 2005a: 3).

Division	Area (km²)	Population	Density
Kahuro	167.9	92,104	552
Kangema	127.7	61,182	479
Kiharu	239.6	84,868	356
Mathioya	220.8	110,139	500
Aberdare Forest	174	-	-
Total	930	348,293	377

Table 1.2. Showing the administrative units, population size and density of Nyeri District, Central Province. Research area is highlighted in red. Source: District's Statistics Office, Nyeri, 2000 (cited in National Co-ordination Agency for Population and Development, 2005b: 3).

Division	Area (km²)	Population	Density
Tetu	279	80,100	287
Mukurweini	180	87,447	459
Mathira	389	150,998	388
Municipality	167	101,238	606
Othaya	171	88,291	516
Kieni West	1,230	68,461	56
Kieni East	850	83,635	98
Total	3,266	661,156	202

1.2.2 Murang'a District

Murang'a District is bordered by Nyeri District to the north, Kirinyaga District to the east, Nyandarua District to the west, and Maragua District to the southwest. The District covers an area of 930 km² with a population of at least 348,293, according to statistics from 1999 (Table 1), and a projected population of 354,334 by the year 2008 (National Co-ordination Agency for Population and Development, 2005a). The population density per km² is high but the growth rate per annum is said to be only 0.2 per cent compared to the Kenya national average of 2.4 per cent. With a high rural population, some of the main problems are land scarcity and over cultivation of what land is available (ibid.). It was observed, during the fieldwork period, that cultivation had extended right up to riverbanks in many areas, thus increasing the possibility of contamination of waterways from agricultural practices (ibid.).

Coffee farming in Murang'a had been badly hit by low prices and corruption, which had led to farmers not even being paid for a few years running; this meant that there were many farmers who were beginning to lose their faith in coffee production and were not maintaining their coffee plots as they would have in previous years. Within Murang'a, interviews took place in Mathioya, Kahuro and Kangema Divisions (Table 1.1). Kangema town was used as the main base during the fieldwork, which meant that the majority of the interviews took place in and around that area due to convenience of distance.

1.2.3. Nyeri District

Nyeri District is located on the southern and western sides of Mt. Kenya, bordering Laikapa District and Meru North District to the north, Kirinyaga District to the east, Nyandarua District to the west and Murang'a District to the south. The District covers an area of 3,266 km² with a population of at least 661,156, according to a census taken in 1999 (Table 2), and a projected population growth of 0.8 per cent per annum (National Co-ordination Agency for Population and Development, 2005b). Similarly to Murang'a District, some of the problems affecting the area are

those of available land and farming activities encroaching on unsuitable land, as well as pollution caused by farming chemicals and deforestation (ibid.).

Interviews were conducted approximately 4 km from Nyeri town, in Mukaro Location of Municipality Division – one of seven Divisions of the District. The situation of coffee farming was said to be slightly different in Nyeri compared to Murang'a and this was attributed to improved factory organisation and a more supportive political situation for coffee farmers (cf. Ovuka, 2000).

The farms visited tended to be along rough tracks spreading outward from the main road and the way they were structured was with the farmer's house built at one end of the farm with any livestock sheds, and plots of crops taking up the rest of the farmland. Many farms were built on sloped land and terracing was widely practised to control soil erosion. Smallholder farms were similarly composed in both Nyeri and Murang'a Districts but farming practices were often different between individual farmers.

1.2.4 The Aberdares

The Aberdare Range forms the eastern wall of the rift valley in the central highlands of Kenya; it lies west of Mt. Kenya, predominantly in the Nyeri District of Central Province (Kenya Wildlife Service, 2007). The mountain range has different ecological zones according to stages in altitude. The National Park designated area lies mainly above the tree line that spreads along the contour at 3000m (ibid.), while coffee is grown at between 1000m and 2000m because of the climatic conditions it requires (FAO, 2007). The main type of coffee grown in Kenya[4] is Arabica because the high altitude is not conducive to Robusta (*Coffea canephora*). Precipitation rates are high and satisfy the requirements of the cash crop, varying across the Aberdare Range from 1000mm to 3000mm per/year (Kenya Wildlife Service, 2007).

[4] Over 90% of coffee production in Kenya and Tanzania is Arabica whereas Uganda's production is 90% Robusta (Nyambo *et al*., 1996).

Effective natural resource management in the Aberdare Range is particularly important because of its position as a vital water catchment area, feeding into the Tana and Athi rivers and part of the Central Rift and Northern drainage basin (Kenya Wildlife Service, 2007). The research location was chosen both because of its position as a 'biodiversity hotspot' (CAFNET, unpub.), due to its proximity to the Aberdare National Park, and its high levels of smallholder coffee farms. Farming practices impact on the environment in many ways and it was felt to be important to look at what was happening in terms of coffee farming and related 'ecosystem services' (Izac, 2003: 32; Millennium Ecosystem Assessment, 2005), which have been explained in the following literature review.

1.3 Rationale

Governmental and local authorities are increasingly concerning themselves with sustainability[5] issues across the world and Kenya is no exception[6]. Often lacking, however, is effective communication and understanding between policy makers and the farmers who implement any changes directly in interaction with the land. The aim of this study was to gain insight into how farmers understand ecological processes and the ecosystem services that their coffee farms could provide in relation to the various scales that Izac (2003) describes[7]. By using a knowledge-based systems (KBS) methodology during the project process, local knowledge that could be articulated by the coffee farmers has been recorded and stored in an accessible[8] format and usable for future research into coffee farming and developments in that sphere (Sinclair and Walker, 1999).

[5] Sustainability is used here as a term to describe a situation whereby natural resource are not degraded and retain the ability to be productive in the long-term; this links in with Chambers and Conway's sustainable livelihood definition with applicable 'capitals' that ensure a livelihood can recover from shocks (1991).
[6] Kenya has signed up to many international agreements that emphasise 'sustainable development' such as the Cotonou Agreement entered into in 2003 (EU, 2007) and the 1993 Convention on Biological Diversity (CIA, 2007).
[7] She identifies four main scales of ecosystem services - farm; watershed/village/landscape; region; global/supraregional (Izac, 2003).
[8] This will be explored more fully in the methodology chapter.

1.4 Research objectives

Research in the field took place from the beginning of June until mid-August and the main aim was to make an assessment of local knowledge about coffee farming systems and ecosystem services, specifically biodiversity, that certain farming practices can provide by:

- **investigating** local knowledge about ecological processes
- **collecting** knowledge about coffee farming and its interactions with the environment that can help inform future development in that area
- **processing** interviews into useful statements and entering them into a knowledge base on AKT5[9] software to make the project results easily accessible to others
- **analysing** the knowledge to elicit any possible gaps in knowledge or richness of knowledge

1.5 Research questions

Broad questions that helped with focusing the research were:

- what are farmer understandings of coffee and its interactions with other tree species and seasonal crops – is it seen as beneficial or detrimental to practice intercropping with coffee?
- have any changes occurred in terms of population of tree/animal species in the study location and surrounding areas?
- what are the main concerns about coffee farming in Murang'a and Nyeri Districts?
- how does coffee income affect farming practices?

The main focus for this project was to find out how much and what coffee farmers knew about species diversity in their coffee plots, on their farms as a whole, as well as in the areas that their farms were situated. Questions were asked concerning animal and plant life in the areas and any population changes that had been noticed in the past twenty years or longer; what contributes to such changes; what influences

[9] Agro-ecological Knowledge Toolkit (*see* Waliszewski and Sinclair, 2004).

coffee farming practices and in what ways this was seen to impact upon ecosystem services such as biodiversity and livelihoods of farmers.

Chapter 2: Literature review

There are various aspects to this research project that need to be examined in light of the current academic literature. The main areas that have been looked at are those of ecosystem services, coffee farming in relation to ecosystem services, local knowledge, conservation and development, and how these topics relate to the research context in Kenya. All are pertinent issues within natural resource development on an international scale.

2.1 Ecosystem services

'Ecosystem services' (Izac, 2003; Millennium Ecosystem Assessment, 2005), 'ecological services' (Altieri and Nicholls, 1999; Altieri, 1991) and 'environmental services' (Sharma, 2002; Gouyon, 2003) have all been terms used to describe the benefits that humans gain from natural resources and the positive impacts on ecological processes that animal and plant life can have.

'Ecosystem services' have been defined as that which humans are reliant on for sustenance, health and livelihoods (Millennium Ecosystem Assessment, 2005). They can also be referred to as 'natural capital', comprising 'all the natural resources that provide useful goods and services for mankind' (Izac, 2003: 32). In comparison, 'ecological services' are those that directly benefit the environment by encouraging biological 'renewal processes' (Altieri and Nicholls, 1999: 70). It could be argued that 'ecological services' indirectly lead to 'ecosystem services' and the boundaries do not seem altogether clear; 'environmental services', as mentioned by Sharma (2002) and Gouyon (2003), appears to be no different in scope to Altieri and Nicholls' 'ecological services' (1999).

2.1.1 Biodiversity as an ecosystem service

Although biodiversity may differ in definition depending on who is using the term, it is used here to describe 'taxonomic richness […] of biota' (West, 1999: 102) within an area of land. Because of the perceived benefits that biodiversity has within

ecosystems[10], it has been cited many times as an example of 'ecosystem service' (Altieri and Nicholls, 1999; Cairncross, 1995; Izac, 2003; Millennium Ecosystem Assessment, 2005). 'Services' provided specifically by biodiversity have been said to be those of *supporting*, *regulating* and *cultural* (Millennium Ecosystem Assessment, 2005), s*ee* Figure 3.1.

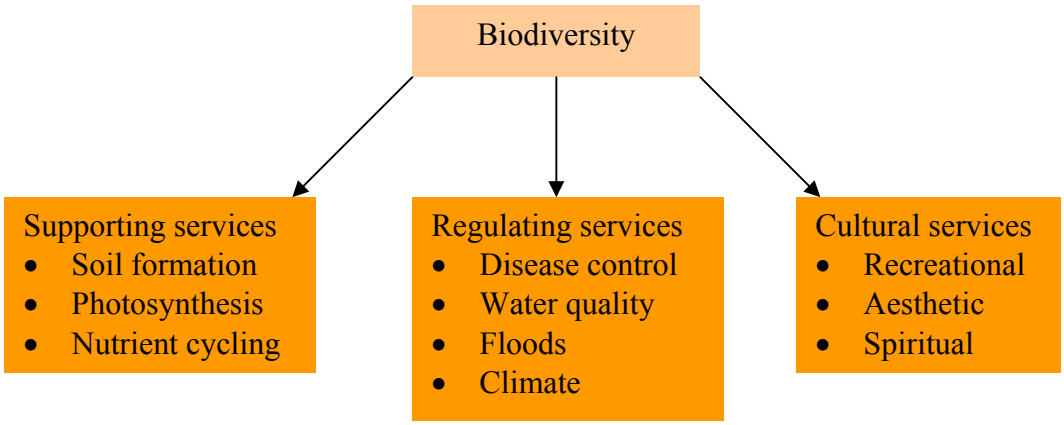

Figure 2.1 Biodiversity and associated services (as elaborated on in the Millennium Ecosystem Assessment, 2005).

The research area has been called a biodiversity 'hotspot' because of its location in the vicinity of the Aberdare National Park and natural forest surroundings and it is thought that local coffee agroforest systems could help ensure habitat for wildlife while simultaneously providing a means of livelihood for local communities (CAFNET, unpub.). A problem said to exist in Kenya, however, is that many trees being planted on farms consist of little diversity, potentially leading to problems of pests and disease spread (Leakey, 1999). This would indicate that biodiversity is important for ecosystems to have the ability to adapt and control fluctuations in diseases or pest populations. Not only does biodiversity provide 'ecosystem services', then, it also ensures valuable 'ecological services' (Altieri and Nicholls, 1999).

[10] 'Ecosystem' has been defined as a 'dynamic complex of plant, animal, and microorganism communities and the nonliving environment interacting as a functional unit' (Millennium Ecosystem Assessment, 2005: *Preface* V).

2.1.2 Coffee agroforests as provision for ecosystem services

The International Union of Forest Research Organisations (IUFRO) establish 'agroforestry as an inter-disciplinary science focused on the practical imperative of assisting farmers, forest dwellers and landscape-level planners in achieving sustainable food, fuel and timber production' (Sinclair, 1995: 1); therefore, biodiversity is a significant area of focus within agroforestry as it provides support services for sustainable production. Although coffee agroforests have been proven in most cases to be not as biodiverse as natural, secondary, or closed forest, they have been shown to be more species rich than simple coffee farming systems and 'full-sun' coffee farming (Altieri, 1995; FAO, 2007; Gillison *et al*., 2004). It has been shown by various studies on biodiversity that the more complex coffee agroforest systems are, the more diverse the species that inhabit it are (Gallina *et al*., 1996; Harvey *et al.,* 2006). Biodiversity is just one of the 'services' that coffee agroforests can play a role in providing (Table 3.1).

Agroforestry[11] practices have been shown in various areas to help mitigate against severe consequences of market instabilities by providing alternative harvests if one crop fails or does not reach a good market price (Sharma, 2002). This is particularly important if looked at in relation to the 'coffee crisis' of recent times (FAO, 2007).

A major area of concern about coffee agroforestry systems in Kenya is that farmers will clear the coffee tree-crop in favour of something else because of the low coffee prices (CAFNET, unpub.; Karanja and Nyoro, 2002; Nyambo *et al*., 1996). Because of the biodiversity that is thought to inhabit coffee agroforests, severe consequences could result from uprooting the coffee trees such as high levels of disturbance in terms of wildlife and wider-scale impacts, for example, on watershed protection (Altieri and Nicholls, 1999; CAFNET, unpub.).

[11] According to Sinclair (1999, cited in Scroth and Sinclair (eds.), 2003), agroforesty can be defined as a set of land use practices that combine elements of woody perennials, agricultural crops and/or animals deliberately on the same area of land so that beneficial interactions can take place between them as well as the farmer (ecologically and/or economically).

Moves have been made to try and increase the sustainability of coffee production by not only introducing the value-added factor but also increasing awareness about the environmental benefits that can accrue at the same time as improved socio-economic conditions (ICRAF, 2007; cf. IISD *et al*., 2003). However, for any long-term improvements in the coffee production of smallholders, there needs to be an increased depth of knowledge and understanding between those involved in the production chain to help towards developing a situation that is less fraught with risk for the coffee farmer (Karanja and Nyoro, 2002).

Literature has stated that shade trees are a common feature of coffee farms in Kenya and the main tree being used for this purpose is *Grevillea robusta*, having been introduced and adopted by coffee planters from the very beginnings of the industry in Kenya (Dewees, 1995). However, other people have said that it has been illegal to intercrop anything with coffee in Kenya, unlike in Uganda and Tanzania where it has been traditionally intercropped with trees and food and fodder crops (Nyambo *et al*., 1996). This is what makes the Kenya situation different to other coffee producing countries, where various coffee agroforestry practices have been encouraged and in existence for many years (Méndez *et al*., 2004; Soto-Pinto *et al*., 2007).

Despite its apparent illegality, Kenyan farmers have been shown in many studies to intercrop trees and seasonal crops with their coffee (Dewees, 1995; Oginosako *et al*., 2006; Ponte, 2004). The reasons for agroforestry are not necessarily for the species diversity it might encourage but rather for the ecosystem services that trees in coffee plots can provide for the farmer, for example, sources of food and timber/fuelwood for home use or cash income (Table 3.1). Not only this, some trees can help against soil erosion which benefits the environment and the farmer at the same time; this can be important within a coffee plot because when the crop is grown on its own the ground tends to have little protection against weathering (Beer, 1987; Ovuka, 2000) (Plate 3.1).

What needs to be remembered is that coffee agroforestry systems can be both detrimental and beneficial, depending on the chosen tree species and how well they interact with the coffee and surrounding environmental factors such as wildlife, soil and climate (Beer, 1987). Ecosystem services are not guaranteed when the classification of 'coffee agroforest' is applied to a coffee plantation; it depends on how the coffee agroforest is managed (Harvey *et al.*, 2006).

Table 2.1. Illustrating the potential 'ecosystem services of agroforestry trees at different scales' (adapted from Izac, 2003: 33).

Scale	Ecosystem functions
Farm	Food production Nutrient cycling Erosion control Water cycling Genetic diversity Microclimate regulation
Watershed/village/landscape	Decreased poverty Erosion and sedimentation control Water cycling Refugia, pollination, biological control (landscape patches)
Region	Decreased poverty Decreased deforestation and desertification Biodiversity Water cycle
Global/supraregional	Greenhouse gas regulation Climate regulation Biodiversity Rural poverty alleviation

Plate 2.1. Coffee being grown largely as a monocrop at Yadini Estate, Ruiru Location. Taken on 27/6/07 by researcher.

2.1.3 Monocropping coffee

The ecosystem services that can be provided by coffee grown on its own is limited in comparison to coffee agroforestry, but there is still a certain amount of habitat provided for wildlife as coffee trees can be fairly bushy and when berries are ripe they are often eaten by birds. Management practices would, however, be likely to deter much wildlife because of the disturbances from pruning, weeding, spraying and picking. It would appear that when there is multi-storey agroforestry being practised, there are alternatives for wildlife to live in other than coffee, which means there can be biodiversity despite coffee farming. With any monocrop there will be less wildlife than if there is a diversity of crops and, as stated by Gallina *et al*. (1996: 24), there is a high correlation 'between fauna diversity and vegetation structure complex' (cf. August, 1983; Williams *et al*., 2001).

Ecosystem services in terms of livelihood for coffee farmers and poverty reduction are more apparent when there are contingency crops to compensate for situations of some crops failing or bad prices (Beer, 1987; Williams *et al*., 2001). When monocropping cash crops, there needs to be confidence in the end result of producing the crop, or enough farm space for different crop plots to 'buffer' any risk associated with the cash crop. In the Kenyan case, large coffee estates largely practice monocropping because they can afford not to intercrop, while most smallholders would monocrop if there was a guaranteed and adequate price for their coffee (cf. Beer, 1987; Williams, *et al*., 2001).

2.2 Local knowledge

Local knowledge has been defined by Sinclair and Walker (1999) as that which is not privileged knowledge but is based on real-life observation and experience, but there are many interpretations of what 'local knowledge' constitutes and means (Greaves, 1996; Strang, 2004). The main differences in definition of local knowledge seem to be that of whether it is culturally shaped or whether it can be separated in a sense from the 'cultural' to become commonly held knowledge. It appears to depend on what is been looked at, for example, in the case of agroecological knowledge there has been shown to be consistencies between people from similar agroecological zones (Berlin, 1992; Sinclair and Walker, 1999), whereas, other types of knowledge may be influenced more heavily by cultural values (Strang, 2004).

Research involving looking at local knowledge in Kenya has proved to be useful because it can show differences in farmer preference for particular tree species and crops depending on agroecological zones as well as cultural values (Oginosako *et al.*, 2006). It is possible to disaggregate cultural values from what could be called agroecological knowledge – knowledge of natural processes and how different species interact with one another in particular environments – but it can also be of value to take into consideration what cultural influences there might be on what is actually planted on farms.

2.3 Conservation activities and development

An important area that needs to be talked about in relation to the research context is development and conservation activities, such as protecting against declining species populations. The issue is whether the two priorities can progress together effectively or whether they are too disparate in their desired outcomes. Both development and conservation are interested in ecosystem services but sometimes for slightly different reasons. People who are concerned about economic development will often utilise conservation measures for their own means (tourism, better prices for their products, etc.), whereas people who are primarily concerned about conservation are often worried about environmental degradation and not for the purpose of gaining profit for themselves (Gouyon, 2003).

Farming practices impact on the environment in many ways and can have widespread effects that are not always obvious. Intensive and high input agriculture is usually perceived as 'development' because of the short-term financial gain that can result, but this directly comes into conflict with 'conservation', which tends to be more concerned about long-term environmental benefits (ibid.). It has been written that environmental services are encouraged most strongly by those who have already achieved economic development because they are the ones who can afford to, but it is the poor farmers in developing countries who can have the most impact on environmental services because their farming practices determine the state of such 'services' (Gouyon, 2003; Munasinghe, 1995). According to Izac (2003), the ecosystem service of biodiversity is one of regional rather than farm scale, perhaps because it is seen as having less of a service to the farmer than the wider population. This is a vital point because if farmers are not rewarded for making sure certain 'services' are available to benefit the wider world, farming practices that can benefit them more financially are likely to take priority (Gouyon, 2003).

Development towards farming that directly benefits the farmer as well as the environment is possible but only if the right market mechanisms are in place and those who make up the production chain value environmental considerations (ibid.).

Chapter 3: Methodology

It is vital in natural resource development that interventions are based on local contexts because they need to be suitable for the people and the environments that they target. A major aspect of the methodology that has been followed during the respective research period is the active participation of local coffee farmers and learning from what they have to say. It is important to address the needs of people rather than impose perceived needs on them and to do this effectively there needs to be understanding of what the main issues are and what constraints there might be to resolving such issues (Laws *et al*., 2003; Sinclair and Walker, 1998).

Ethical issues had to be considered before and during the fieldwork, as it was important for this particular project to record basic details of participants (e.g. name, age, profession, location) in order for their contributions to be acknowledged and traced back to them if necessary. Informed consent was ensured before the recording of their details and it was only in one case that the name of an interviewee was not recorded because of non-consent. Nobody was pressurised into participating in the research project, it was on a voluntary basis. The researcher endeavoured to talk to participants at appropriate times for them and did not ask inappropriate questions that were not relevant to the study. Before the fieldwork took place, guidelines for ethical conduct were consulted (RESPECT, 1997)[12].

3.1 Knowledge based systems (KBS) approach

For this research, a KBS methodology has been used that has been developed by University of Wales, Bangor; systematic collection of ecological knowledge of those involved directly with farming and development is promoted by this method (Waliszewski and Sinclair, 2004). There are four main stages to this methodology but the fourth was not developed for this particular research period because of time constraints; it involves testing the representativeness of the acquired knowledge across the study area and requires random sampling and statistical analysis (Walker

[12] See Appendix 2 for further ethical considerations.

and Sinclair, 1998). The three main stages that have been carried out over the recent research period are given below.

3.1.1 Scoping stage

The 'scoping stage' is effectively the introduction period to the study area and local people. During this time the researcher began to identify any variability within the community that could influence who knows what; this enabled the researcher to define who would be useful to interview in terms of the research objectives. Walker and Sinclair write that the scoping stage of research is the appropriate time to design a detailed 'knowledge acquisition strategy' (1998: 375). Knowledge acquisition involves elicitation of knowledge, representation and evaluation – such aspects were thought about in detail during the first few weeks of 'scoping' to ensure an effective approach to the research.

3.1.2 Definition of domain

Defining the domain entails setting preliminary boundaries to what the knowledge base will be about and the areas to cover during the research period (Waliszewski and Sinclair, 2004). Informants were purposively selected according to willingness to participate and coffee farming experience. These individuals helped to identify local taxonomies in relation to the environment (trees, birds, animals etc) that helped the researcher reach an understanding of local names and what they referred to. Not only were interviewees helpful in this regard, other people from the study areas also helped verify names and set the context for the study.

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3.1.3 Compilation

The compilation stage is an iterative cycle where purposively selected key informants from each of the defined strata (defined according to perceived variability in possible knowledge[13]) are repeatedly interviewed and interviews are analysed until the relevant knowledge has been exhausted (Dixon *et al*., 2001;

[13] Variability could be due to age, occupation, gender, ethnicity, location; whichever seems to impact the most on agro-ecological knowledge will determine the stratification (Dixon *et al*., 2001).

Sinclair and Walker, 1999). Although repeat interviews with participants were aimed for, this proved to be only possible in a couple of cases due to time constraints on farmers and researcher. The repeat interviews that did take place were worthwhile and added value to what had been said in the previous interviews by interviewees repeating or disputing what they had previously stated. Repeat interviews were also valuable for gaining greater detail on particular topics that needed more probing according to post-interview analyses.

Individuals were the main focus for interviews during this research but often there would end up being a few additional farmers at interviews and this only proved to be problematic when the additions drowned out the original farmer. Towards the end of the research period, feedback sessions were arranged in three of the main areas where interviews had taken place (Plates 3.1 and 3.2); they provided the opportunity to discuss and check for inaccuracies or misunderstandings that could have occurred on the part of the researcher. Not only were the feedback sessions important for clarifying any issues, they were also a way of informing farmers about the project, its future aims, and encouraging future participation.

3.2 Sampling strategy

It was decided that the sampling strategy would be purposive, convenience, self-selecting and snowballing, a mixture of non-random sampling methods. Non-random sampling is more convenient when there is little time to construct an adequate 'sampling frame' to accommodate a random sampling strategy (Nichols, 1991). It was important to be realistic with how much could be achieved in the time given so the most appropriate methods could be utilised (ibid.). Sampling was purposive when the researcher wanted to visit specific farms that appeared to cover a range of different coffee farming practices; convenience when distance or time was an issue; self-selecting when farmers asked to be interviewed; snowballing when farmers recommended other farmers to visit and helped show the way to their farms.

Plate 3.1. Nelson Muiru and Genevieve Lamond holding a feedback session at Kamagogo coffee factory in Mathioya Division. Taken on 8/8/07 by researcher.

Plate 3.2. Farmers participating at a feedback session held at Kamagogo coffee factory in Mathioya Division. Taken on 8/8/07 by researcher.

3.3 Methods for knowledge elicitation

During fieldwork, it was important to be flexible in order to adjust methods because some methods were more effective and contextually appropriate than others. An aspect of this was translation because sometimes it was felt to be more useful to let interviews be conducted in the local languages (Kikuyu and Swahili) when there was a particularly good flow of information – it was vital in this case for the interview to be recorded and the translator/research assistant to then go through the recording and write down all that was said. This was not a regular occurrence but when it did happen it was only after the translator/research assistant had worked closely with the researcher and understood what to ask and how to ask questions in the interviews. The research methods used during this research period were influenced by the Participatory Learning and Action (PLA) tradition, which encourages triangulation by mixing techniques of gathering information (Laws *et al*., 2003).

3.3.1 Interviewing

The most appropriate approach for the relevant knowledge to be acquired was a combination of semi-structured interviews[14] (SSI) and depth interviews[15]. An important consideration when conducting interviews was avoiding the use of inappropriate questions (Laws *et al*., 2003) such as the following:

- leading questions
- questions that are vague and hard to answer
- questions that contain value judgements
- questions that could be deemed offensive, and
- multiple questions posed simultaneously.

[14] SSI has been defined as 'guided conversation in which only the topics are predetermined and new questions or insights arise as a result of the discussion' (Pretty, 1995). See Appendix 3 for the SSI template.

[15] Depth interviews are more conversational that SSIs; the topic area can still be defined but there is more opportunity for the participant to lead the discussion according to what s/he thinks is important to talk about (Laws *et al*., 2003).

During interviews it was often the case that there were short periods of silence and these were left as time for thought and answers, rather than time to fill with more questions. However, when there was a distinct lack of response the researcher and research assistant tried asking questions in slightly different ways to see if the knowledge was there and just needed to be triggered off by the right questions. Because the researcher and translator/research assistant had attended the same methodology training there was shared understanding about how to approach interviews and this helped a lot in the field.

Location of interviews was especially important because of the nature of the research project; wherever possible they were conducted on interviewees coffee farms so the researcher and farmer had reference points to discuss. Timekeeping was also important and interviews were kept to between 1-2 hours to avoid intrusion into peoples' daily routines, so participants did not get tired or bored, and it was a manageable amount to process (cf. Laws *et al*., 2003).

3.3.2 Visual methods

Visual techniques for knowledge acquisition can be highly useful as a way of involving people in the research process, especially if people find it hard to express what they know in words. A vital aspect to successfully using visual methods is letting participants draw or explain where/what/when things are without the researcher interfering (Laws *et al*., 2003). The following methods were used with farmers to add to what could be gathered from interviews:

- Farm sketches were drawn by four of the farmers and this helped to illustrate where particular crops and trees were commonly grown in relation to one another (represented in results section).
- A bird book was used to help farmers identify bird species in the areas and on their farms – this proved particularly useful as before the book was utilised farmers found it hard to name more than a few birds in their mother tongue[16].

[16] The birds identified can be seen in Appendix 4.

- Some farmers described the routines that they were supposed to follow throughout the year and one farmer wrote down his coffee farming calendar for growing, pruning, spraying etc.[17] – this provided a good representation of seasonal changes throughout the year and when particular farming practices were to come into action, thus, providing valuable contextual information (*see* Guijt, 1998).
- The feedback sessions held towards the end of the research period involved posters of the main research findings and a few points for clarification – they were held up for discussion and any comments were written down in front of everyone[18]. These sessions brought forward some areas of conflict between coffee farmers and also reinforced where there was strong agreement between them (cf. Nabasa *et al*., 1995). A total of 45-50 farmers attended the feedback sessions, with good numbers at each to enable discussion and room for everyone to have a chance to give some input.

3.4 Assessing elicited local knowledge

A knowledge base[19] was developed during the fieldwork, with analysis and processing of interviews taking place as soon as possible after each interview – there was usually time between translations to make adequate notes and the voice recorder also helped on occasions, but memory of the context was also important. Interviews had to be assessed as soon as possible so that the researcher could decide what needed to be clarified and further questions to ask. This was part of the iterative process that is vital within the KBS methodology (Waliszewski and Sinclair, 2004).

Project meetings were also held every three weeks, with supervisors at ICRAF and colleagues from the Natural History Museum and Coffee Research Foundation; these were important times to discuss progress and brought up relevant areas that needed more exploration to answer the research questions.

[17] See Appendix 5.
[18] See Appendix 6 for a sample of the sheets used for the feedback sessions.
[19] Consult Dixon *et al*. (2001) for a comprehensive guide to knowledge base formation and AKT5 software.

Often there were areas that were not clear from interviews because farmers had different opinions and experiences of coffee farming. The time given to discuss any problematic areas during project meetings, feedback sessions, and further interviews with farmers, was vital to gain a clear picture of what farmers really meant and where differences in knowledge lay.

3.5 Usefulness of the method

The aim of developing a knowledge base was not to provide statistics of how many people said what but rather as a tool to further knowledge about ecological processes and increase awareness about 'local knowledge'. The AKT5 methodology was used to assist research by providing a means of bringing together findings in an interactive format. Photographs of visited farms were taken and entered into the Kenya Knowledge Base, source information was kept up to date and linked to the correct statements, and causal diagrams were generated to show linkages between stored statements (examples given in results section). In terms of usefulness for this research project, AKT5 was invaluable because it encouraged systematic collection of local knowledge while providing the means for this knowledge to be in an accessible format that could help inform research and/or development decisions in the future (Waliszewski and Sinclair, 2004).

The knowledge base was also developed with the intention for it to be utilised by CAFNET for their project aims of 'connecting, enhancing and sustaining environmental services and market values of coffee agroforestry in Central America, East Africa and India' (CAFNET, unpub., Annex 1) (Figure 3.1).

Figure 3.1. CAFNET research sites, *http://www.ifpindia.org/Coffee-and-EnvironmentalServices-in-the-Western-Ghats,397.html.*

3.6 Limitations of research

3.6.1 Time limitations

The major constraint felt during fieldwork was time for more interviews and greater coverage of Nyeri District, in particular. In the case of Nyeri, there was much time spent arranging meetings and walking to farms, only to find that farmers were not available. These farmers were successfully interviewed in the end but there was a lack of other available farmers in the area, which was explained as a reluctance to have researchers see their farms because of coffee neglect. Even though farmers in Kangema District were also neglecting their coffee plots, they were more enthusiastic about having researchers visit. Perhaps this was because they felt there would be resultant benefits if they participated, this was indicated by what was said at the feedback sessions. There was a need to try and lower expectations of what the research would ultimately lead to, but this was difficult considering it had to be explained as part of the larger project of CAFNET[20].

[20] See Appendix 7 for the brochure that was given to farmers and others interested in the project.

It would have been good if there had been more time available for repeat interviews with farmers and for more participatory methods to have been used during fieldwork (more farm sketches, ranking and scoring exercises, focus group discussions). What was managed to fit into interview times was felt to be adequate considering the amount of time available. It was often felt that after an hour farmers were being held up from doing something else and were getting tired of questions. It was also tiring for the researcher to continue asking questions and keep up with what was being said for longer than an hour.

Sometimes interviews ran into two or three hours but these were usually based on more relaxed and informal conversations about coffee farming and other topics of interest for the farmer; they were just as important for the success of the research because they built good relations as well as bringing up information that was not thought of during the more structured interviews. If there had been more time, more of these 'depth' interviews might have been possible and resulted in a greater understanding of coffee farmers and their knowledge of farming practices, the environment, and their own position within the coffee processing chain.

3.6.2 Methodology limitations

A necessary but sometimes frustrating aspect of the AKT methodology was processing interviews into the knowledge base computer program. It was difficult at first to process interviews quickly and it had to be done before interviews started piling up. The problem was that interviews were sometimes easier to cluster together in a few days rather than spread out over the week, but this meant there were many to get through at the same time. Ideally, there would have been a couple of interviews and then time to process them before moving onto the next farmers. A factor that hindered working on the knowledge base was the frequent power cuts, but notebooks compensated for what could not be done on the laptop (except when the power cuts were at night). When power returned, the interviews had already been partially processed on paper and were then entered into the knowledge base with improvements added.

3.6.3 Sampling limitations

The aim was for at least five people to be interviewed in each of the research areas, so as to see whether there was any distinct shared knowledge and different farming practices according to location, but this did not prove to be possible in Nyeri Municipality Division. Four interviews were held in Municipality, while in the Divisions of Murang'a District, ten farmers were interviewed in Mathioya, eight in Kangema, and six in Kahuro. This meant that the sampling of areas was not very consistent and would be an area to improve upon if the research was to take place again. The non-random sampling methods also meant that the data collected was not reliably representative of the population under study, but this was partially overcome by having feedback sessions which showed to an extent where there were shared understandings of what had been brought up in interviews. The last stage of the KBS methodology would have acted as a check on representativeness of the knowledge collected, if there had been time to carry it out.

Chapter 4: Results

The following results stem from the various methods that were employed to find out agro-ecological knowledge of coffee farmers and the context in which this knowledge was situated. To begin with, farm layouts that were drawn by a small proportion of the interviewed farmers have been presented to give an idea of typical smallholder farms in the study locations. From there, the Kenya knowledge base (KB) has been explored to illustrate what the coffee farmers knew about their coffee farming and its interactions with the wider environment. As a means of further verification about what individual farmers said, results from the three feedback sessions held towards the end of the research period have also been mentioned.

4.1 Farm sketches

Four farm sketches were collected from farmers during interviews and they represented what could have been called 'typical' smallholdings in the study areas, in terms of size and production. From comparing the sketches with what was said during the interviews, interesting points became apparent and have been explored further in the proceeding sections and discussion chapter.

4.1.1 Characteristics of farms in study areas

The size of the farms included in this study were between 0.5 acres (0.2 ha) and 20 acres (8.1 ha) and had variable proportions dedicated to coffee (*Coffea arabica*) production, ranging from 0.25 acres (0.1 ha) to 6 acres (2.4 ha). Rather than typical, out of the 28 farms visited there was only one farm that was 20 acres, one that was 9 acres (3.6 ha), one that was 8 acres (3.2 ha), and one that was 6.5 acres (2.6 ha); most of the farms were of a smaller size ranging between 0.5 acres and 5 acres (2 ha). These were figures given by the farmers themselves rather than measurements taken during the research period. In some cases the farmers were not able to give a figure for the size of their farms.

Farms were crop based with a mixture of cereals, vegetables, fruits, grasses, and trees for fuelwood and timber. In terms of livestock, the majority of farms had at

least one cow to produce milk for home consumption and manure for the crops, some chickens and occasionally a few goats (one farm had a couple of pigs but that was not commonplace). Out of the four farm sketches, only one farmer decided to include his cow/goat shed but he still omitted the presence of a chicken shed (*see* Diagram 4.4). Omitted features of farms in the sketches are important to note because otherwise an inaccurate portrayal of the farms could be given, and it was interesting to observe what farmers did not include in the sketches and why this might have been. With reference to the chicken shed and other indications of livestock that did not appear in the farm sketches, there did not seem to be a good explanation other than the farmers perhaps drawing what they thought was required by the exercise and this being the layout of their crops. Livestock played an important role on the farms, however, by lessening the burden of little income by providing meat, milk and manure.

4.1.2 Income and intercropping issues

According to the farmers interviewed, at the time of the study, they could not depend wholly on coffee as a means of livelihood because the price they received for the ripe berries had dropped so low as to make losses rather than profits. This was said to have happened over the past 10 to 20 years (since the late eighties to mid-nineties up until the year of this study), a range of years given by different farmers but all in agreement that coffee could not be relied on as a cash crop as it had been in the past.

As can be seen from the farm sketches given below, smallholdings in the research areas consisted of various crop plots for means of subsistence and for selling at the marketplace. Crops other than coffee that were most commonly grown on the farms were bananas, maize, napier grass, various types of beans, kales and cabbages. Additional crops found on some interviewee's farms were arrowroot, sugarcane, sweet potatoes, cassava, passion fruit, yams, chilli peppers, tomatoes, pumpkins and pineapples. The most common fruit trees were avocado, macadamia and bananas and these were usually planted on their own, although, farmers stated that bananas

were being grown increasingly as an intercrop because of the need to compensate for the losses made from coffee.

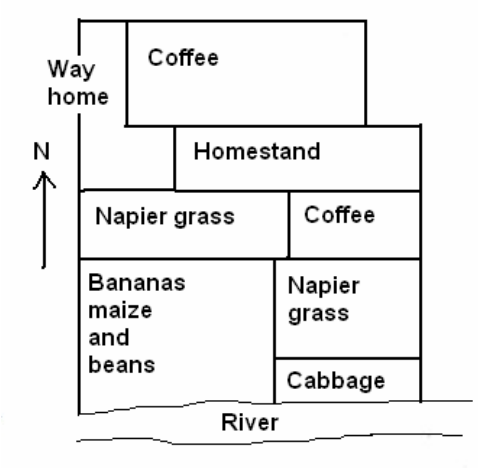

Figure 4.1. Farm layout adapted from sketch by Edwin Irungu Kamenya, Kahuro Division, Murang'a District 30/7/07.

In the above farm sketch (Figure 4.1) there were apparently no intercrops being grown with the coffee, however, the farmer chose not to draw them together despite the reality of intercropping beans, maize and bananas for subsistence. The reasoning the farmer gave was that if producing coffee provided a sufficient income he would not intercrop with coffee because it diminishes the quality of the coffee berries and increases competition for nutrients. Therefore, the farmer's reluctance to draw the crops in the same plot was because it was not deemed good practice or normal practice for well managed coffee. Similarly, both farmers who drew the farm sketches in Figures 4.2 and 4.3 (given below) did not include the beans or potatoes they were intercropping in the representations of their coffee plots. Interestingly, the farmers were willing to talk about their farming practices of intercropping with coffee, yet, did not feel the need to commit to sketch such practices.

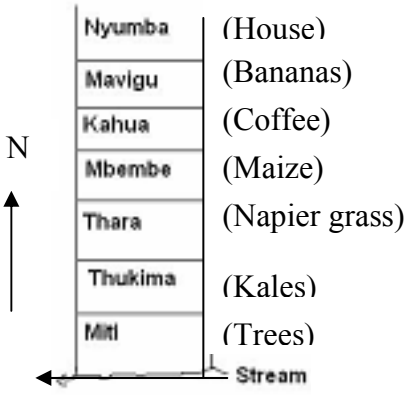

Figure 4.2. Farm layout adapted from sketch by Mary Njeri and Isabel Wangari. Kangema Division, Murang'a District 19/6/07.

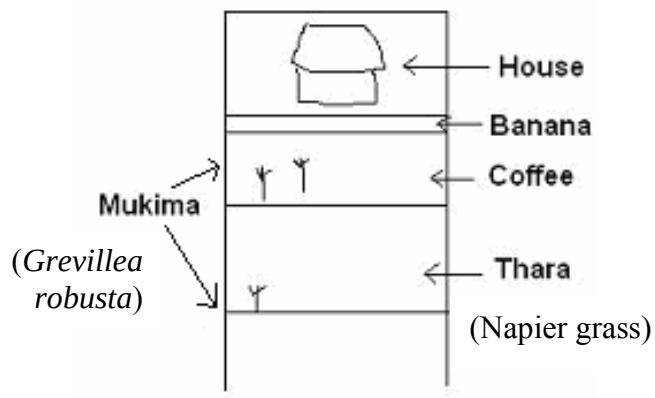

Figure 4.3. Farm layout adapted from sketch by Githira Maina, Kangema Division, Murang'a District 22/6/07.

As has already been mentioned, there was considerable crop diversity within smallholder farms in the research locations. With reference to particular crop plots and species diversity, coffee was the main crop being intercropped at the time of research (despite this not being represented by the farm sketches), although, the majority of farmers stated that this would stop if they received an adequate price for their coffee (explored further in the following KB section).

In Figure 4.4 (below), the sketch shows that there was a separate plot for trees that were specifically utilised for fuel, construction timber and cash sales, according to the farmer. The reasons given for distinctly separating the trees and food crops were that there was enough land on that particular farm for different plots and the trees would not allow anything, let alone crops, to grow underneath them because of the dense canopy. Again, as mentioned previously, what was observed and talked about during the interview was not reflected completely in the pictorial representation of the farmer's farm. In this case, the farm sketch did not get drawn containing the few macadamia trees (*Macadamia integrifolia*) that were present in the coffee plot, the nuts being used as a means of supplementary income. Trees have also been shown in Figure 4.4 to have an additional purpose other than provision of means of livelihood – this farmer was using them to support the riverbank against erosion.

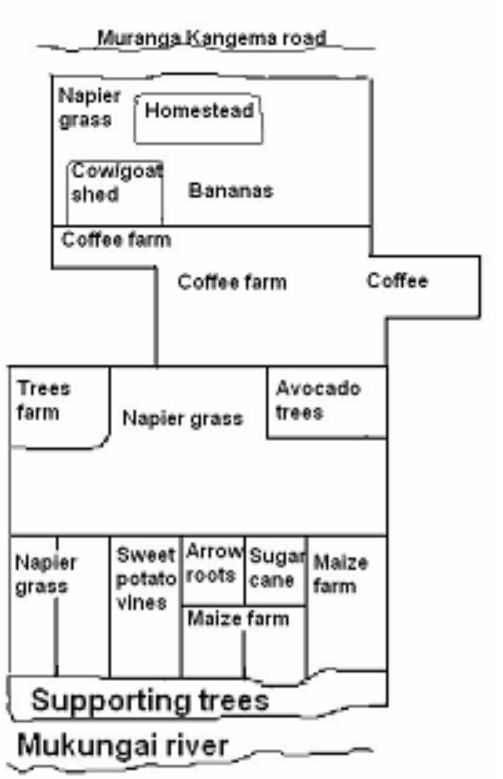

Figure 4.4. Farm layout adapted from sketch by Francis Gichimu Githuku, Kahuro Division, Murang'a District 23/6/07.

Figure 4.4 provides an example of the amount of crops that could be grown in separate plots, in the research areas, when farm size was adequate (in this case the farm was 1.5 acres (0.6 ha)). In relation to farm size, an issue that was beginning to surface was the subdivision of farms within families. It was explained by farmers that Kikuyu custom required giving sons a share of the family farm, for them to build a house and grow their own crops on. If the farm depicted in Figure 4.4 was to be subdivided into four to provide for sons, it is not hard to imagine what might happen to the diversity of crops; which ones would take priority would depend on factors such as required subsistence foods, livestock feed, and required cash income (mentioned further in the following KB section).

4.2 Kenya knowledge base (KB)

The Kenya KB contains statements representing knowledge extracted from 31 interviews that were conducted in seven locations (Githiga, Kiru, Marimira, Mūgūrū, Mukaro, Njumbi and Weithaga) over four divisions (Kangema, Kahuro, Mathioya and Nyeri Municipality) and two districts (Murang'a and Nyeri) in Central Province, Kenya.

Four of the interviews were conducted with two farmers at each, while the rest of the interviews were with individuals despite passer-bys often stopping to listen and make a few comments. Three of the interviews were repeats with previous interviewees, undertaken to probe deeper into the farmer's knowledge than one interview would allow. If time had allowed, more of the farmers would have been asked to participate in further interviews because it proved to be very useful in adding more substance to and verifying what had been said during the initial interviews.

From analysing the interviews, a total of 546 statements were entered into the KB; 345 of them directly linked to coffee while the other statements concerned the wider environment and farming practices. The vast majority of statements in the KB showed cause and effect relationships (360 in total) and these are called **causal** statements. Such statements indicate that farmers were able to give valuable explanations and make connections between processes rather than just give descriptive replies to questions. There were also many **comparison** statements (99 in total), resulting from farmers often comparing particular attributes of different coffee varieties and other crops (e.g. rooting depth). These comparison statements could be used to aid decision-making concerning, for example, suitability of different species for intercropping.

Through examining the Kenya KB, particular themes became apparent from the knowledge elicited from the farmers who participated in the study. There were both strongly shared areas of knowledge and areas that were better known by individual

farmers because of their own on-farm experimentation. The themes that have been pulled out to look at in this results section concern the pertinent issues of ecosystem services in relation to coffee farming; major shapers of coffee farming; farmers' knowledge of coffee diseases and pests.

4.2.1 Ecosystem services

4.2.1.1 Species diversity in local areas, on farms and in coffee plots

The general consensus concerning wild animals in the research locations, as demonstrated in the Kenya KB, were that more cultivation had led to less bushy[21] areas and this had in turn displaced many animals that would usually have hidden in them. Large mammals (such as, various types of antelope, including dik-diks (*Madoqua sp.*), monkeys (including ngimas[22], nguyos[23] and baboons (*Papio cynocephalus*)) and hyenas (*Hyaenidae sp*.)) were all said to have declined in the study areas because of increased cutting down of trees and clearing of bush for the purposes of cultivation over the last 30 years – although, it was said during interviews that previously there had not been large numbers of these animals anyway. Porcupines (*Hystrix cristata*) were said to be more common in tea plantations because of their preference for bushes rather than coffee plots with little undergrowth, but their numbers were said to have also declined.

Statements from the KB contain the knowledge that if particular crops were available on farms there would be an influx of animals to feed on them, although, not usually enough to be problematic[24]. In comparison to farms without coffee, it was stated that farms with coffee had less wild animals probably because coffee is not a good source of food for much wildlife and management of coffee is disruptive.

[21] The terms 'bushy' and 'bush' are used here to mean dense wild vegetation.
[22] Kikuyu name for what is thought to be *Cercopithecus mitis* (blue monkey).
[23] Kikuyu name for what is thought to be *Colobus guereza* (black and white colobus).
[24] Except in one case, given by a farmer, that is not represented in the KB, whereby all his tomatoes and some other crops were getting cleared by what he called a 'useless bird' (otherwise called 'muthu' in Kikuyu or 'speckled mousebird' in English) and he was taking measures to control the problem.

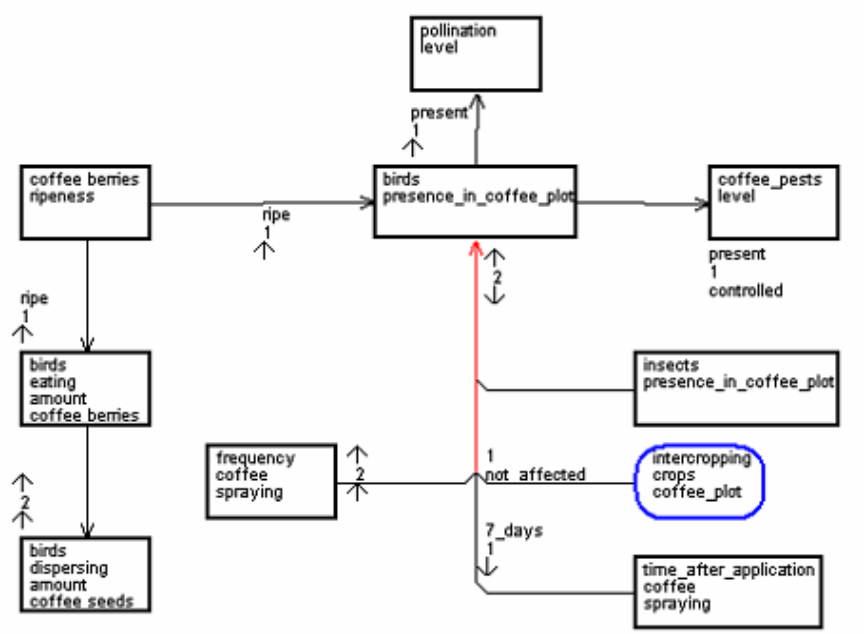

Figure 4.5. Causal diagram representing farmers' knowledge of birds and coffee. Nodes represent human actions (boxes with rounded corners) or attributes of objects, processes or actions (boxes with straight edges). Arrows connecting nodes denote the direction of causal influence. The first small arrow on a link indicates either an increase (↑) or decrease (↓) in the causal node, and the second arrow on a link refers to an increase (↑) or decrease (↓) in the effect node. Numbers between small arrows indicate whether the relationship is two-way (2), in which case ↑A causing ↓B also implies ↓A causing ↑B, or one-way (1), which indicates that this reversibility does not apply. Words instead of small arrows denote a value of the node other than increase or decrease (e.g. when coffee berries are **ripe**, there is an increase in birds eating them).

When questioned about wild animals in coffee plots in comparison to other crop plots on their farms, many farmers commented that other crops attracted more birds[25], moles (*Chrysochloris stuhlmanni*), and non-specified 'wildlife' than coffee. Crops that were said to be more attractive food sources and habitats for wild animals were maize, banana and napier grass. Fruit crops such as banana, avocado, macadamia and tomato were said to specifically attract many birds. According to the farmers, birds were to be found in coffee mainly when the berries were ripe or when there were insects to feed on, which was more likely when spraying had not taken place. How often and when coffee was being sprayed was deemed an important

[25] Local birds in the research areas are given in Appendix 4.

factor of bird numbers in coffee plots, as was berry ripeness and the presence of insects (Figure 4.5). Birds were seen to have an impact on coffee pest populations and pollination (out of birds, it was said to be sunbirds that contributed the most to this process), as well as dispersal of seeds through eating coffee berries.

Although the processes of pollination and seed dispersal were mentioned, they were not talked about frequently or in any great depth during interviews. Farmers said they would usually buy seedlings from research centres and these would be more productive than if they were grown from seed on farms, and pollination was not often stated as influencing coffee productivity[26] (cf. Kinuthia *et al.*, 2004).

Statements in the KB reflect that when coffee plots were neglected, farmers said there was more wildlife in them because of decreased practices such as weeding, pruning, picking and spraying. And, as asserted by the majority of farmers, at the time of research, coffee plots were not being managed as intensively as they would have been if farmers were receiving a good price for their coffee. Apparently, chameleons (*Chamaeleo sp*.), birds and 'green snakes' (undefined species) were all increasingly present in coffee plots when there was a decrease in management and they were also said to be useful in controlling coffee pest populations. Although valued for their pest control, farmers expressed reluctance to depend wholly on the predators if they had a choice.

Most farmers said that if they had enough money they would continue to follow the factory recommendations of chemical application to coffee. Nonetheless, there were a few exceptions, one being a farmer in Mūgūrū Location who had noticed her coffee trees developing natural resistance to pests and diseases once she had stopped applying chemicals so she had no intention to begin again. Another farmer, from Njumbi Location, was intentionally farming his coffee organically and said that he had stopped spraying and applying fertilisers eight years previously – with levels of

[26] See Appendix 8 for a KB causal diagram representation of the main influencers on coffee productivity.

production the same as before and no problems of coffee berry disease or leaf rust (common coffee diseases).

Although a very small number of farmers were practising organic farming and others had knowledge about it, other farmers seemed to have an unclear understanding of which farming products constituted being 'eco-friendly'. An example was when a farmer said that 'eco-friendly' organic chemical pesticides had been developed by agricultural suppliers Farmchem and they were being used for coffee farming; he named them as Farsban and Danadim, which were both classed as organophosphorous insecticides. The farmer commented that by using chemical sprays such as these there would be less harm done to bees, particularly important during coffee flowering when they were said to be valuable for cross-pollination.

During interviews, there was little value given to wild animals and awareness about the importance of species diversity to the international community (discussed in the next chapter). Not only this, most of the farmers showed little concern about decreases in numbers of wild animals because it was said to lead to less crops being damaged.

4.2.1.2 Reasons for intercropping

Knowledge about intercropping was strongly evident during interviews as a result of most of the farmers practicing it within their coffee plots. The main reasons for intercropping were:

- means of additional cash income, and
- provision of subsistence goods that farmers would not have been able to afford to buy.

There appeared to be another reason and this was given as making use of coffee plots rather than completely abandoning them. Farmers were often reluctant to uproot the coffee trees despite the lack of income they were generating, and they recognised that the manure and fertilisers being applied to intercrops would benefit the coffee as well. So, by incorporating food crops and trees into their coffee plots,

farmers were ensuring alternative livelihood strategies and trying to protect their farms from erosion. They were aware that abandoning their coffee plots would have meant less maintenance of important terraces that kept together a lot of the farmland in the research areas. A farmer in Kiru Location, for example, had abandoned his coffee plot, but then decided to revamp it by intercropping banana and cover crops to restore the soil and bind it together effectively; these practices also provided some sort of subsistence and cash income while coffee was proving to be an ineffective means of livelihood (Figure 4.6).

The reasons given for intercropping were not often about the benefits that such practices would have for coffee, more often, farmers were making excuses for intercropping and blaming it on low coffee prices. There was recognition, though, that shade from trees intercropped in coffee plots could be beneficial during hot and sunny spells, whereby coffee trees next to banana/grevillea (*Grevillea robusta*) would retain a healthy dark green colour to their leaves. During the research period it was winter months and days were often wet and foggy, which might have influenced the replies of farmers about the importance of shade in coffee plots; some farmers were talking about more shading leading to more moisture and lessening the temperature of coffee plots, which was said to heighten the risk of fungal diseases like coffee berry disease (CBD) (Figure 4.7).

The majority of farmers expressed that, by intercropping, they were sacrificing higher yields of coffee because of the competition between crops (for sunlight, nutrients, water and rooting space). For this reason, if coffee prices were to increase to an acceptable amount, farmers would uproot their intercrops to grow coffee on its own for higher yields and, therefore, more money (cf. Williams *et al*., 2001). But, many farmers also said that competition between crops was something that could be managed effectively; they said that as long as spacing between intercropped trees was wide, that extra manure/fertilisers were applied, that trees with a large canopy were pruned, the effect on coffee productivity would be minimal (Figure 4.7).

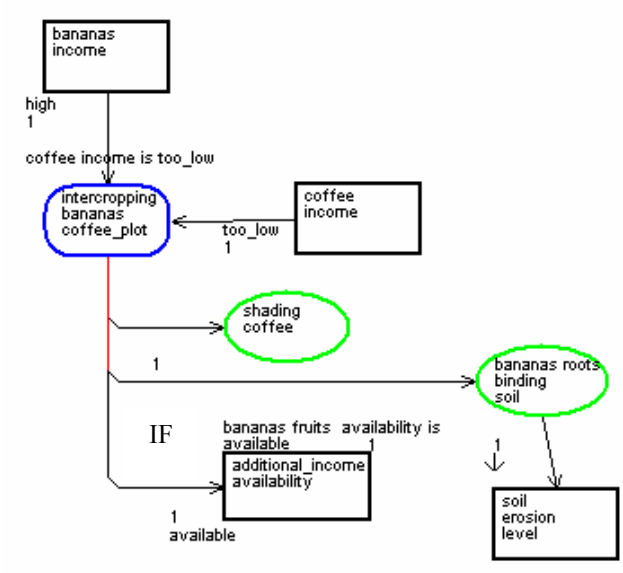

Figure 4.6. Causal diagram showing connections between intercropping banana in coffee plots, the environment and farmer income. Diagrammatic symbols are the same as explained in Figure 4.5 but this diagram also contains nodes that represent natural processes (ovals) and conditions (IF) that appear next to the nodes that they refer to (e.g. intercropping bananas provide additional income IF bananas fruits are available).

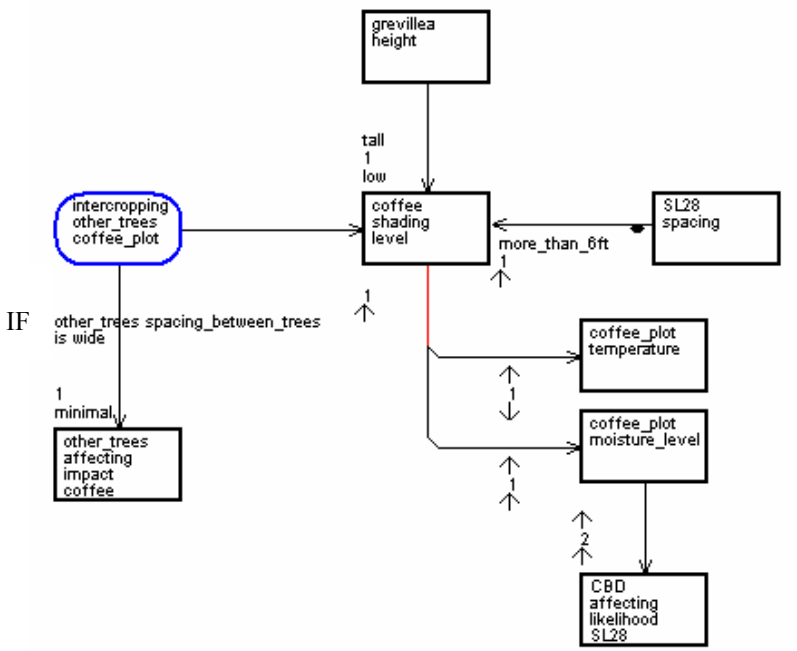

Figure 4.7. Causal diagram showing causes and effects of shading in coffee plots (SL28 is a common variety of arabica). Diagrammatical symbols are the same as described in Figures 4.5 and 4.6, as well as a black dot on a causal arrow indicating a negation of the node it is coming from or going to (e.g. SL28 spacing is **not** more than 6 ft causes the shading of coffee to increase).

4.2.2 Major shapers of coffee farming

4.2.2.1 Price received for coffee

As has already been mentioned in the previous section, the price that coffee farmers received for their coffee berries was cited as a major influence on how coffee was managed (Figure 4.8). When costs for optimum production outweighed the resultant income, farmers became discouraged from maintaining their coffee plots as advised by coffee factories and extension workers (*See* Appendix 5). Coffee was said to still produce even while coffee plots were not well looked after, but some farmers had the problem of not having time to do the harvesting themselves or being able to hire labour due to monetary constraints. Another issue of cash income was that farmers often said that there were more problems of diseases and pests when they could not afford to spray chemicals to control infestations. Such constraints on productive coffee farming meant that there had been an increase of uprooting coffee trees in favour of 'more useful crops', for example, napier grass which could both be sold and used to feed domestic cattle.

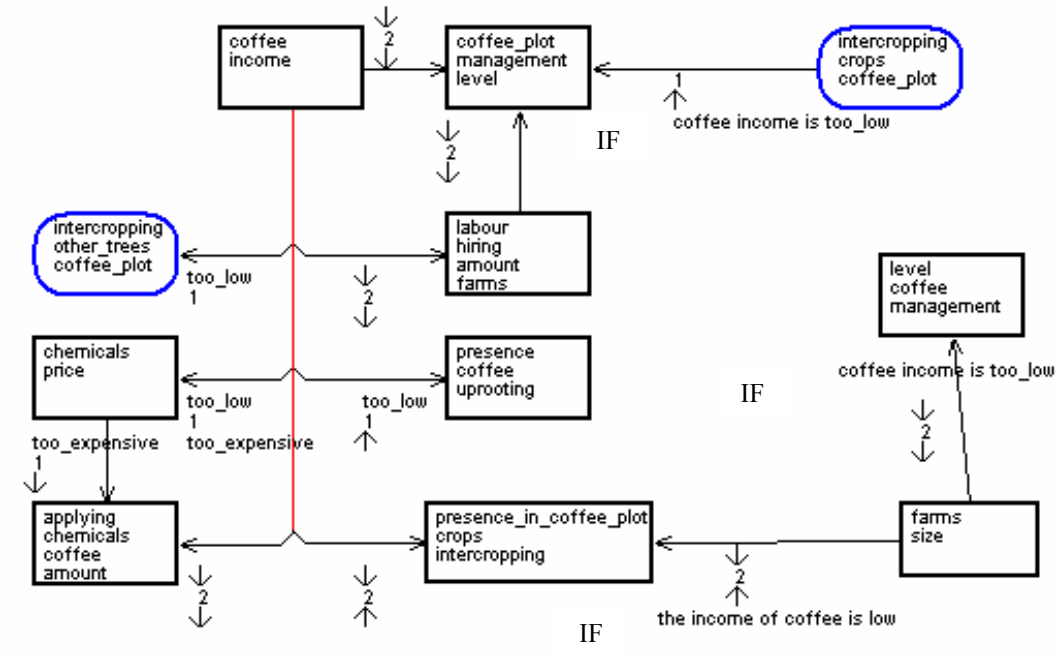

Figure 4.8. Causal diagram to show effects of coffee income on farming practices. Diagrammatical symbols are the same as described in Figures 4.5 and 4.6.

4.2.2.2 Factory recommendations

The factories that the farmers were delivering their coffee to often had regulations concerning the management of coffee plots, such as spraying regimes and what could be intercropped without harming coffee quality. It was evident in the different research areas that there were slightly different rules set by factories for farmers to follow, and they also differed as to how strict they were in enforcing these rules. Although farmers were aware of factory regulations, they were also very aware of having to provide for themselves and their families and this meant that factory rules often could not be strictly followed. The only tree that was recommended for intercropping with coffee (and only if it was really necessary) was grevillea, according to farmers, because it was said not to be harmful to the growth of coffee (cf. Oginosako *et al.*, 2006). Although that was a widespread recommendation, as talked about previously, many farmers had other trees present in their coffee plots for various reasons. The farmers had their own knowledge from experience about which trees could be grown with coffee without too much adverse affect on production and they also had strong opinions about certain trees' unsuitability for intercropping (*see* Table 4.1 in the following section about the feedback sessions).

While interviewing farmers in Nyeri Municipality Division, it was stated that if farmers were observed to have been breaking particular rules, the factory they were delivering to would ban them. But, even in this case, there were farmers who were intercropping cover crops and trees although such practices were forbidden. For this reason, it was said that people were not as willing to be interviewed on their farms as farmers in the other areas, where factories were not so vigilant. Over all research areas, there were only a few farmers who were not intercropping and felt so strongly against it that they would not carry out such practices to supplement a poor coffee income.

4.2.2.3 Subdivision of farms

As was briefly touched upon in the previous section on farm sketches, there appeared to be an important issue of population growth and farm subdivision that

was said to pose problems for the near future, if not already (cf. Bebe, *et al*., 2003; Norton-Griffiths and Southey, 1995). Reducing farm size was felt to have impacts on coffee farming that would become greater if further subdivisions of farms were to take place in the study areas. The main consequences, as already indicated (Figure 4.8), were said to be:

- uprooting coffee to make room for what were often deemed 'more useful' crops, and
- increasing intercropping to make use of smaller areas of farmland.

Not only were these views given because of the above farming practices being in process at the time, they were also given with the younger generations in mind and the lack of optimism they were said to have for coffee in comparison to the older generations whose educations were often founded on coffee farming.

4.2.3 Diseases and insect infestations

Leaf rust (*Hemileia vastatrix*) was said, in a few cases, to be evident when 'worms' (larvae) or 'caterpillars' were in coffee plots, whereas other farmers stated that it was a fungal disease. There were mixed replies when asked about conditions for leaf rust to occur – some farmers said it was during the rainy season while others said it was during the dry season.

Coffee scales were not acknowledged by many farmers, whereas others were able to point to them and describe what they were feeding on (coffee tree sap) as well as what feeds on the scales. There were mixed accounts of what was causing blackening of coffee trees. Some farmers said it was the excrement of muthigiriri (Kikuyu name for small black ants) that caused the blackening and did not acknowledge the presence of scales, while other farmers said that it was because of the scales that the muthigiriri were there because they provided them with sweet excrement to feed on. The farmers who expressed knowledge about an interaction between scales and muthigiriri thought it was dead scales that caused the blackening.

4.3 Results from the feedback sessions

The main topics covered in the feedbacks sessions were

- intercropping,
- wildlife, and
- concerns about coffee farming.

The sessions provided the opportunity for farmers to discuss what had been said as individuals during interviews, and make any other comments they wanted to before the research came to an end. Most of what was presented to the farmers was accepted with agreement but extra points were made which proved useful[27].

4.3.1 Intercropping

During the feedback sessions it was stated that since the beginning of coffee farming, farmers had been taught that anything growing under coffee was considered to be weed and that intercrops could affect the end taste of the coffee beans. There were particular crops that would definitely not be intercropped; these were strong tasting crops like chilli peppers and onions. Short crops were deemed less competitive with coffee for nutrients and the main acceptable intercrops were potatoes and beans – beans were also said to add nutrients to the soil. Some farmers did say that intercropping would not reduce yields as long as extra manure and fertilisers were added, but this was a contentious issue with other farmers commenting on the fact they could not afford any 'extra'.

When discussing trees in relation to coffee farming, the farmers considered the costs and benefits of certain trees and these are presented in Table 4.1. There were other trees mentioned as benefiting soil and the environment (*Bridelia micrantha*, *Erythrina abyssinica*, *Cordia abyssinica* and *Neubotonia macrocalyx*) but they were not classed as suitable for growing on farms or with coffee because of the amount of space they were said to require.

[27] See Appendix 6.

Table 4.1. Main trees that farmers mentioned in relation to coffee farming.

Crop name (Latin/English/Kikuyu)	Main use	Main noted qualities that affect coffee if intercropped	Presence in coffee plots
Eucalyptus saligna/ bluegum/ muringama	Timber	1. Heavy feeder 2. High water requirements	Absent
Acacia mearnsii/ black wattle/ mūthandūkū	Fuel	1. High nutrient requirements 2. Prone to caterpillar infestations	Occasionally present
Macadamia integrifolia/ macadamia	Nuts	1. Additional income outweighs disadvantages such as dense canopy and competition for nutrients	Occasionally present
Musa/ banana/ marigu	Fruits	1. Water retention is high which is good for coffee when it is dry season 2. Can minimise effects of frost	Often present
Ricinus communis/ castor/ mbariki	To reduce impact of frost on coffee	1. Provides shelter for coffee from onslaught of frost conditions	Rarely present
Grevillea robusta/ silky oak / mukima or mūbariti	Timber/ fuel	1. Affects coffee production the least adversely	Often present

4.3.2 Wildlife in coffee plots

Different intercrops were said to attract different wildlife and it was also said to depend on the stage of growth of intercrops as to what would be attracted. More intercrops in coffee plots were said to provide breeding sites for butterflies; maize encouraged more birds in coffee plots; beans attracted more mammals and insects when flowering. The farmers said that they did not care much about more animals being in their coffee plots because they had ceased to care about their coffee. However, there was agreement among farmers that more animals in the local areas would not be good for farming.

At one of the feedback sessions (Kangema), it was said that bees, wind and butterflies were the main facilitators of coffee pollination and spraying before pollination would lead to lower yields; whereas, at another feedback session (Mathioya) spraying was said to affect bird and bee populations in coffee plots but not pollination. This is an important issue, particularly because farmers were concerned about yields and how to increase them without too much expense.

4.3.3 Concerns about coffee farming

When asked of their concerns about coffee farming, the farmers said that the following areas were of greatest importance to them:

- **good markets**, whereby the price reflects the effort put into farming and the quality of the coffee. The farmers wanted more information regarding the coffee market and increased communication along the production chain;
- **education**, to learn best practices for farming coffee; which varieties to grow; spraying requirements; how to farm in environmentally friendly ways if that is how they will receive a better price for their coffee;
- **high yields**, and
- **quality**.

There was recognition that the way that coffee was being farmed when there was a lower price for coffee was less damaging to the environment because of less chemical applications, but it was not sustainable as a livelihood.

Chapter 5: Discussion

In this section, the results have been discussed with direct reference to the main research questions and relevant scientific literature. It is important to look at the research results in comparison with what has been said by scientists who have undertaken research in the same country or on similar subject matter; this can help further understanding of the farmers' knowledge, as well as show differences or similarities between scientific and local knowledge (Joshi *et al.*, 2004).

5.1 What are farmer understandings of coffee and its interactions with other tree species and seasonal crops – is it seen as beneficial or detrimental to practice intercropping with coffee?

Intercropping with coffee was largely described by farmers as detrimental to coffee growth and yields, if insufficient manure and fertilizers were added to coffee plots to compensate for the extra feeders. This correlates with what Beer (1987) lists as disadvantages of intercropping, but he also states that it is important to get the right mix so that competition does not interfere with crop productivity. Farmers were well aware of the crops that did not affect coffee as much as others and preferred these as intercrops (usually short term cover crops like beans and potatoes).

There was the assertion from farmers that intercropping had been discouraged by factories and agricultural officers, with anything under coffee being considered 'weed', and Nyambo *et al.* (1996) state that it has been illegal to intercrop with coffee. This indicates that others along the coffee chain consider intercropping to be detrimental to coffee production and, thus, this impacts on coffee farming practices, despite many farmers acknowledging that it is often just a matter of applying enough manure and fertilisers for coffee not to be adversely affected. A reason given for not intercropping certain crops was that they were 'strong tasting' and change the taste of the coffee berries, but this was said to be something that was reported to farmers rather than having tasted the difference themselves. The benefits from intercropping are said to be many by scientists (Beer, 1987; Boffa, 2003; Ponte, 2004) and there

must be truth in it if there are coffee farmers in many countries other than Kenya purposely intercropping their coffee, whether the coffee price is up or down.

5.2 Have any changes occurred in terms of population of tree/animal species in the study location and surrounding areas?

5.2.1 Tree populations

The main changes for trees that were noted by farmers in the study areas were that there were less indigenous trees because they had been chopped down extensively for charcoal, fuelwood, and construction timber. Introduced trees that were present in high numbers were *Grevillea robusta* and *Eucalyptus sp.*, this was also found in a study by Oginosako *et al.* (2006). The majority of farmers reported impacts from the large numbers of *Eucalyptus sp*., for instance, drying up of land because of the tree being a heavy feeder, which was said to make it unsuitable to be grown with any crops (cf. Noad and Birnie, 1989). There has been widespread concern in Kenya about the effects of *Eucalyptus sp.* on the land and Rumley and Ong (2007) mention the problems associated with its high water requirements when it reaches maturity. In comparison, studies have shown that in areas of the world that have high rainfall and fertile soils, competitive trees like *Eucalyptus deglupta* are used by farmers as shade trees in coffee without problems (Scroth, 2003). The importance of comparative studies is that they can show where some trees are better suited for than others.

It was said by farmers that indigenous trees were better for the environment than those that had been introduced, with particular reference to mulching material and soil fertility (cf. Beer, 1987). The problem was that they did not feel that they had enough space on their farms for indigenous trees because of their larger rooting depth and spread than the fast growing species that had been introduced for commercial reasons. A deeper rooting depth was valued because it meant less competition with crops, and during the dry season deep roots would still be able to draw up water, thus benefiting crops nearby (banana was said to be useful for this purpose when intercropped with coffee). Such knowledge expressed by farmers is

correlative with what scientific articles contain, for example, Scroth (2003) and Teixeira *et al*. (2003).

Although recognised for their greater environmental services, indigenous trees have been sacrificed in return for fast-growing timber trees which benefit farmers financially. This shows an example of trade-off between profitability and benefits for the environment – which would potentially lead to increased farmland fertility (cf. Williams *et al*., 2001).

5.2.2 Animal populations

The main consensus from farmers about changes in animal populations was that increased cultivation and associated clearing of bush had led to decreases in medium sized mammals (primarily monkeys, hyenas, antelopes and porcupines). Ovuka (2000) is in agreement with the impacts that clearing of bush land has had in Central Kenya, and associates the introduction of coffee with such land use changes. Unlike other coffee producing countries, Kenyan coffee policy has meant that agroforestry practices are not well incorporated into coffee farming systems and are often practiced haphazardly according to the needs of the farmer (Nyambo *et al*., 1996).

Coffee farming appears to have had an impact, then, on decreased species numbers in the study areas. Although coffee plots on individual smallholder farms do not usually cover a large area, the coffee plot number in a landscape can be great, particularly in this project's research location. Again, whether intentional or not, a trade-off can be seen between profitability of a crop and environmental services, in this case animal species diversity (cf. Williams *et al*., 2001). Nonetheless, multi-storey coffee agroforests exist in other coffee producing countries (as mentioned previously) and they allow for species diversity as well as a cash crop, indicating that the trade-off that appears to exist in Kenya does not need to be so.

5.3 What are the main concerns about coffee farming in Murang'a and Nyeri Districts?

The concerns expressed by farmers in Murang'a and Nyeri were predominantly about the price that they were receiving for their coffee berries and how this could be improved. Concerns were not about the impact of coffee farming on the environment and biodiversity, and this is not surprising given the context of poverty that most of the farmers were embedded in (cf. Gouyon, 2003).

5.4 How does coffee income affect farming practices?

Because coffee is a cash crop and is not grown for any other reason, the income from it will largely determine how it is managed; this was the majority view given by the farmers who were interviewed. If coffee was not bringing in any profit to the farmer, s/he was said to have little option about reducing inputs because management was deemed too expensive if the crop was not making any returns. The resultant effects were said to be increased wildlife in coffee plots but lower yields and increased presence of diseases and insect infestations because of not being able to afford to spray with fungicides and pesticides. Alternatively, there is a suggestion that less spraying of agrichemicals would allow natural enemies of pests to also increase and, thus, biological control to take place (Nyambo *et al.*, 1996). Such a situation could be thought of as a reverse trade-off between biodiversity and profit, but with little choice of most farmers. Only a couple of farmers spoke about natural regulation that came into effect after some years of not using chemical applications on their coffee trees.

5.5 Conflicting knowledge

From looking at the results, a few areas were brought to light whereby individual farmers had different explanations for natural processes and science had yet another explanation. It is not for this research project to say which explanation is correct but to encourage exploration of different explanations to promote understanding between farmers and scientists. Two examples have been given, one concerning coffee scales and the other concerning pollination of coffee.

5.5.1 Knowledge of coffee scales

With reference to what farmers said about coffee scales, as presented in the results chapter, and their differing opinions of what was causing the blackening of the coffee trees, the existence of scales, and interactions between the scales and muthigiriri, the scientific opinion is slightly different to the farmers'. According to scientific knowledge, coffee scales and muthigiriri have a relationship whereby the scales provide the muthigiriri with food and the muthigiriri provide the scales with protection from predators (Winston *et al*., 2005). Scientific knowledge also attributes the blackening to a mould that has a black sooty appearance (Plate 5.1) and develops on the excrement of the scales (ibid.). None of the farmers interviewed mentioned the blackening being caused by mould; they either attributed it to ant excrement or dead coffee scales.

Plate 5.1. Blackened coffee leaves caused by mould. Taken on 23/7/07 by researcher.

5.5.2 Knowledge of pollination

Pollination was not a topic that farmers could explain in depth and many did not associate the process with higher coffee yields, perhaps because coffee is self-pollinating to an extent. Recent studies have, however, shown higher yields of coffee when pollination by bees/flies/beetles has occurred (Kinuthia *et al*, 2004; Klein *et al*, 2003; Nyambo *et al*., 1996). A few farmers mentioned that they were being encouraged to have beehives on their farms but they were not convinced of the value of doing so.

As mentioned in the results section, different farmers had different views on the value of pollination and what helped the natural process take place; some thought that bees and butterflies were important pollinators, whereas other farmers did not have an answer when questioned about the process. Not only is pollination of value for higher yielding coffee, according to Klein *et al*. (2003), but the diversity of bees that act as pollinators is of importance as well. Klein *et al*. state that 'single flower visits from rare solitary species [of bees] led to higher fruit sets than with abundant social species [of bees]' (2003: 955), thus, indicating that it is in the interests of coffee farmers to hear about studies like these so they can make choices about what farming practices would be most beneficial for them.

Chapter 6: Conclusion and recommendations

The farmers interviewed evidently had a certain amount of knowledge concerning wildlife on their farms and in their localities and could explain changes in species populations, impacts of trees on the environment, and animals that were useful for pest control. With reference to 'ecosystem services', the farmers had little inclination to talk about services that a diversity of animal species could provide but had plenty to say about the effects of a low coffee income on coffee farming and the ecosystem services that the resultant intercropping practices were providing for them (predominantly poverty reduction). Most of the farmers were practicing coffee farming in a way that was regarded by them as more environmentally friendly because of decreased management of the coffee plots, but, they were not proud of how their coffee plots looked because intercrops were not encouraged by factories or agricultural officers in those areas. The fact was that their primary cash crop was not making any cash for them so they had to resort to other measures for providing for themselves.

The results and discussion, as presented in the previous chapters, have illustrated that the research objectives have been met successfully. Local knowledge of ecological processes was investigated by the questions asked during interviews; this knowledge, as well as that of coffee farming and its interactions with the environment, was collected and processed into a knowledge base on the AKT5 software; then, the knowledge was analysed and findings were able to be discussed.

For coffee farming in the study areas to continue to be as environmentally friendly as it was in the face of low prices during project fieldwork, a rethink is required about what agricultural officers and factories should be promoting as good coffee management practices. There is also a need to educate farmers about the importance of environmental protection from degradation because of sustainability issues, and training to show effective means of coffee farming without having to use expensive chemical applications. Organic coffee farming was little understood in the study areas and there is no certified organic coffee as yet from Kenya; there was also little

knowledge about fair trade or other certification schemes that are supposed to support farmers in efforts towards more sustainable coffee production systems.

To develop upon the research that was undertaken for this project, a recommendation would be for research to be conducted in other coffee growing areas of Kenya (e.g. Thika and Kiambu Districts) in order to gain more insight into farmers knowledge and practices, and how these might differ depending on different climatic conditions and regulations of societies and estates. Doing this could prove useful for shaping any appropriate future development in the area of coffee farming in Kenya.

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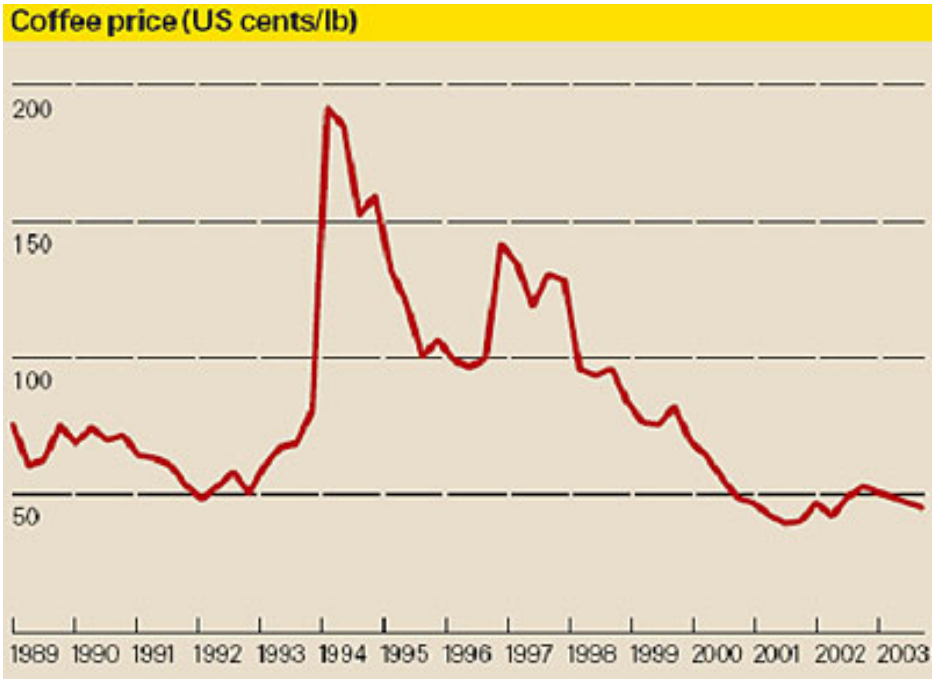
Appendices

- **Appendix 1: Trends in coffee price**
- **Appendix 2: Ethical Statement**
- **Appendix 3: Semi-structured interview checklist**
- **Appendix 4: EXCEL spreadsheet of birds identified**
- **Appendix 5: Coffee growing and preparation**
- **Appendix 6: Sample of sheets used at feedback sessions**
- **Appendix 7: Brochure for coffee farmers**
- **Appendix 8: KB causal diagram for coffee productivity**

Appendix 1: Trends in coffee price



Graph showing the recent decline in returns from coffee production (FAO, 2007).

Appendix 2: Ethical Statement

The ethical principles that were guiding this project were those of the RESPECT code of practice for socio-economic research that can be found on *http://www.the-sra.org.uk/documents/pdfs/respect_code.pdf*. The research that was undertaken had been considered in light of three main underlying principles that RESPECT promotes:

1. **Upholding scientific standards**
2. **Compliance with the law**
3. **Avoidance of social and personal harm**

1. *Upholding scientific standards*

The methodology that was used throughout the project was designed in a way that research questions would not be leading and any outcome of the research was not predetermined. All relevant information gathered during the research was recorded in a way that was accessible to those in the study area and open for dialogue to avoid misunderstanding between the researcher and participants. As it was important for this particular project to record basic details of participants (e.g. name, age, profession, location) in order for their contributions to be acknowledged and traced back to them if necessary, informed consent was ensured before the recording of their details. All research findings have been reported truthfully, comprehensively, and without distortion; clarity was sought when there were any areas of doubt.

2. *Compliance with the law*

Data protection and intellectual property laws were complied with by acknowledging sources and obtaining consent before recording any personal details and details of interviews. Only relevant data was collected and any information gathered has been kept as accurate as possible. The researcher had a duty to be open to the people in the study area about the purpose of the research and to give feedback when necessary. Local and national laws and customs of Kenya and the UK were observed.

3. *Avoidance of social and personal harm*

Nobody was pressurised into participating in the research project, it was on a voluntary basis. The researcher endeavoured to talk to participants at appropriate times for them and did not ask inappropriate questions that could have caused discomfort. The project was not benefiting one group over another in terms of material gain, and the researcher was open to any relevant contributions from all sectors of society. Anybody that the researcher was working with or coming into contact with during the research was treated with respect and any risk of physical, social or psychological harm was minimised wherever possible.

Appendix 3: Semi-structured interview checklist

Introductions and explanation of research project.

Record:

- Name of interviewee(s)
- Occupation(s)
- Age(s)
- Location, division, district
- Date of interview

An outline of questions to ask (only used if thought to be relevant during the interview):

- Are there any noticeable differences between amount of animals in coffee plots and other crop plots on the farm? If so, why do you think this is?
- Have you noticed any changes in animal populations over the last 20 years in the area? If so, what has happened to cause these changes?
- Have you noticed any changes of tree species in the area over the last 20 years? If so, why do you think this is?
- Has coffee farming changed over the years? If so, in what ways?
- Are there any problems of diseases in your coffee? If so, what preventative measures do you take, if any?
- Are there times in the year that diseases are more present? If so, what do you think are the causal factors?
- Are birds present in coffee plots? If so, why?
- What birds are most common in coffee plots/on farms/in area?
- Do chemical applications affect the amount of animals found in coffee? If so, in what ways?
- What is your opinion of intercropping with coffee?

Appendix 4: EXCEL spreadsheet of birds identified as inhabiting study areas according to interviewed farmers

Birds in Kiru Location, Mathioya Division			
English name	*Latin name*	*Kikuyu name*	*Times identified*
Black kite	*Milvus migrans*	Hungu	2
Ring-necked dove	*Streptopelia capicola*	Ndutura	3
Red-eyed dove	*Streptopelia semitorquata*	Ndutura	3
Common bulbul	*Pycnonotus barbatus*	Undefined	1
Pied crow	*Corvus albus*	Igogo	1
African paradise flycatcher	*Terpsiphone viridis*	Undefined	1
Black and white waxbill	Undefined	Undefined	1
African firefinch	*Lagonostica rubricata*	Kanyoni ka kanja	3
Hamerkop	*Scopus umbretta*	Karogi ngunu	3
Scarlet tufted malachite sunbird	*Nectarinia johnstoni*	Kanyua cui	2
Baglafecht weaver	*Ploceus baglafecht*	Thonjo	4
Grey crowned crane	*Balearica regulorum*	Mu-hau	3
Helmeted guineafowl	*Numida meleagris*	Nganga	1
Hadada ibis	*Bostrychia hagedash*	Magogo	2
Fiscal shrike (Common fiscal)	*Lanius collaris*	Thuriu	2

Birds in Mukaro Location, Nyeri Municipality Division			
English name	*Latin name*	*Kikuyu name*	*Times identified*
Undefined	Undefined	Ngoru	1
Swallows	Undefined	Thungururu	1
Augur buzzard	*Buteo augur*	Rwigi/ngoru	2
Doves	*Streptopelia sp.*	Ndutura	2

Speckled mousebird	*Colius striatus*	Muthu	4
Cinnamon chested bee eater	*Merops oreohates*	Undefined	1
Silvery-cheeked hornbill	*Ceratogymna brevis*	Undefined	2
Crowned hornbill	*Tockus alboterminatus*	Undefined	1
Fiscal shrike (Common fiscal)	*Lanius collaris*	Thuriu	2
Streaky seed eater	*Serinus striolatus*	Undefined	2
Cape robin chat	*Cossypha caffra*	Undefined	1
Woodpeckers	Undefined	Ngong'a-kong'i	2
Red-cheeked cordon-bleu	*Uraeginthus bengalus*	Undefined	1
Sunbirds	Undefined	Undefined	3
Firefinches	Undefined	Undefined	2
Baglafecht weaver	*Ploceus baglafecht*	Thonjo	3
Common robin	Undefined	Undefined	1
African goshawk	*Accipiter tachiro*	Rwigi	1
Undefined	Undefined	Ndihu	1
Pallid honeyguide	*Indicator meliphilus*	Undefined	1
Common bulbul	*Pycnonotus barbatus*	Undefined	1
African paradise flycatcher	*Terpsiphone viridis*	Undefined	1
Pied crow	*Corvus albus*	Igogo	1
Hunter's cisticola	*Cisticola hunteri*	Undefined	1
Kenya rufous sparrow	*Passer rufocinctus*	Undefined	1
Pin-tailed whydah	*Vidua macroura*	Undefined	1
African citril	*Serinus citrinelloides*	Undefined	1
Black and white mannikin	*Lonchura bicolor*	Undefined	1

Rwigi/ngoru/hungu were all names used to refer to birds of prey that ate chickens and during the feedback sessions when we tried to clarify the birds, new ones came up like sparrowhawk for rwigi, black kite for ngoru, hungu for augur buzzard it seemed that the Kikuyu names were

interchangeable for these birds of prey.

Birds in Muguru Location, Kangema Division			
English name	*Latin name*	*Kikuyu name*	*Times identified*
Augur buzzard	*Buteo augur*	Ngoru/rwigi	1
Common fiscal	*Lanius collaris*	Thuriu	1
Red-bellied paradise flycatcher	*Terpsiphone viridis*	Undefined	1
Olive thrush	*Turdus olivaceus*	Undefined	2
Pied crow	*Corvus albus*	Undefined	1
African paradise flycatcher	*Terpsiphone viridis*	Undefined	2
Red-cheeked cordon-bleu	*Uraeginthus bengalus*	Undefined	2
African firefinch	*Lagonistica rubricata*	Kanyoni ka kanja	2
Hamerkop	*Scopus umbretta*	Karogi ngunu	2
Scarlet tufted malachite sunbird	*Nectarinia johnstoni*	Kanyua cui	1
Baglafecht weaver	*Ploceus baglafecht*	Thonjo	2
Blue-capped cordon-bleu	*Uraeginthus cyanocephalus*	Undefined	1
Silvery-cheeked hornbill	*Ceratogymna brevis*	Undefined	1
Hadada ibis	*Bostrychia hagedash*	Magogo	1
Fiscal shrike	*Lanius collaris*	Thuriu	1
Hybrid red-bellied paradise flycatcher	*Terpsiphone rufiventer*	Undefined	1
Rupels robin chat	*Cossypha semirufa*	Undefined	1
White-browed scrub robin	*Cercotrichas leucophrys*	Undefined	1
African pied wagtail	*Motacilla aguimp*	Kariithi	1
Yellow-bellied waxbill	*Estrilda quartinia*	Undefined	1

Black and white mannikin	*Lonchura bicolor*	Undefined	1
Grey crowned crane	*Balearica regulorum*	Undefined	1
Joyful greenbul (?)	*Chlorocichla laetissima*	Undefined	1
Magpie shrike (?)	*Corvinella melanoleuca*	Undefined	1
Tacazze sunbird	*Nectarinia tacazze*	Undefined	1
Rufous sparrow	*Passer rufocinctus*	Undefined	1

The birds with question marks beside them are those that were unlikely to be in the area due to their usual range.

Birds in Weithaga Location, Kahuro Division			
English name	*Latin name*	*Kikuyu name*	*Times identified*
Black kite	*Milvus migrans*	Hungu	1
Swallows	Undefined	Thungururu	1
Red-eyed dove	*Streptopelia semitorquata*	Ndutura	1
Ring-necked dove	*Streptopelia capicola*	Ndutura	1
Augur buzzard	*Buteo augur*	Rwigi/ngoru	3
Hornbill (not in book)	Undefined	Undefined	1
Woodpecker	Undefined	Undefined	1
African pied wagtail	*Motacilla aguimp*	Kariithi	1
Pied crow	*Corvus albus*	Igogo	1
African paradise flycatcher	*Terpsiphone viridis*	Undefined	1
Robin chats	Undefined	Undefined	1
Hunter's cisticola	*Cisticola hunteri*	Undefined	1
Scarlet tufted malachite sunbird	*Nectarinia johnstoni*	Kanyua cui	1
Kenya rufous sparrow	*Passer rufocinctus*	Undefined	1
Baglafecht weaver	*Ploceus baglafecht*	Thonjo	3

African firefinch	*Lagonostica rubricata*	Kanyoni ka kanja	1
Cuckoo shrike	Undefined	Wabuli	1
Streaky seed eater	*Serinus striolatus*	Undefined	1
Grey crowned crane	*Balearica regulorum*	Mu-hau	1
Hamerkop	*Scopus umbretta*	Karogi ngunu	3
Speckled mousebird	*Colius striatus*	Mithu	2
Hadada Ibis	*Bostrychia hagedash*	Magogo	2
Undefined	Undefined	Kanywa aii	2
Bats	Undefined	Huhu	1

Appendix 5: Coffee growing and preparation (example given by Githira Maina, Muguru Location, Kangema Division 22/6/07)

January - flowering (spray with liquid pesticides)

February – short rains –weeding and DAP (diamonium phosphate) fertiliser application

March – pruning suckers

April – onset of long rains (spray liquid pesticides to protect young berries and copper to protect against cold)

May – end of long rains – weeding and applying CAN to enhance berry growth

June – spray against cold with liquid pesticides mixed with copper powder} 3 week intervals

July - spray against cold with liquid pesticides mixed with copper powder} 3 week intervals

August - spray against cold with liquid pesticides mixed with copper powder} 3 week intervals

September – pruning of suckers (spray liquid pesticides and copper)

October – start ripening (apply NPK 17:17:17 to prepare coffee for January)

November – start ripening (apply NPK 17:17:17 to prepare coffee for January)

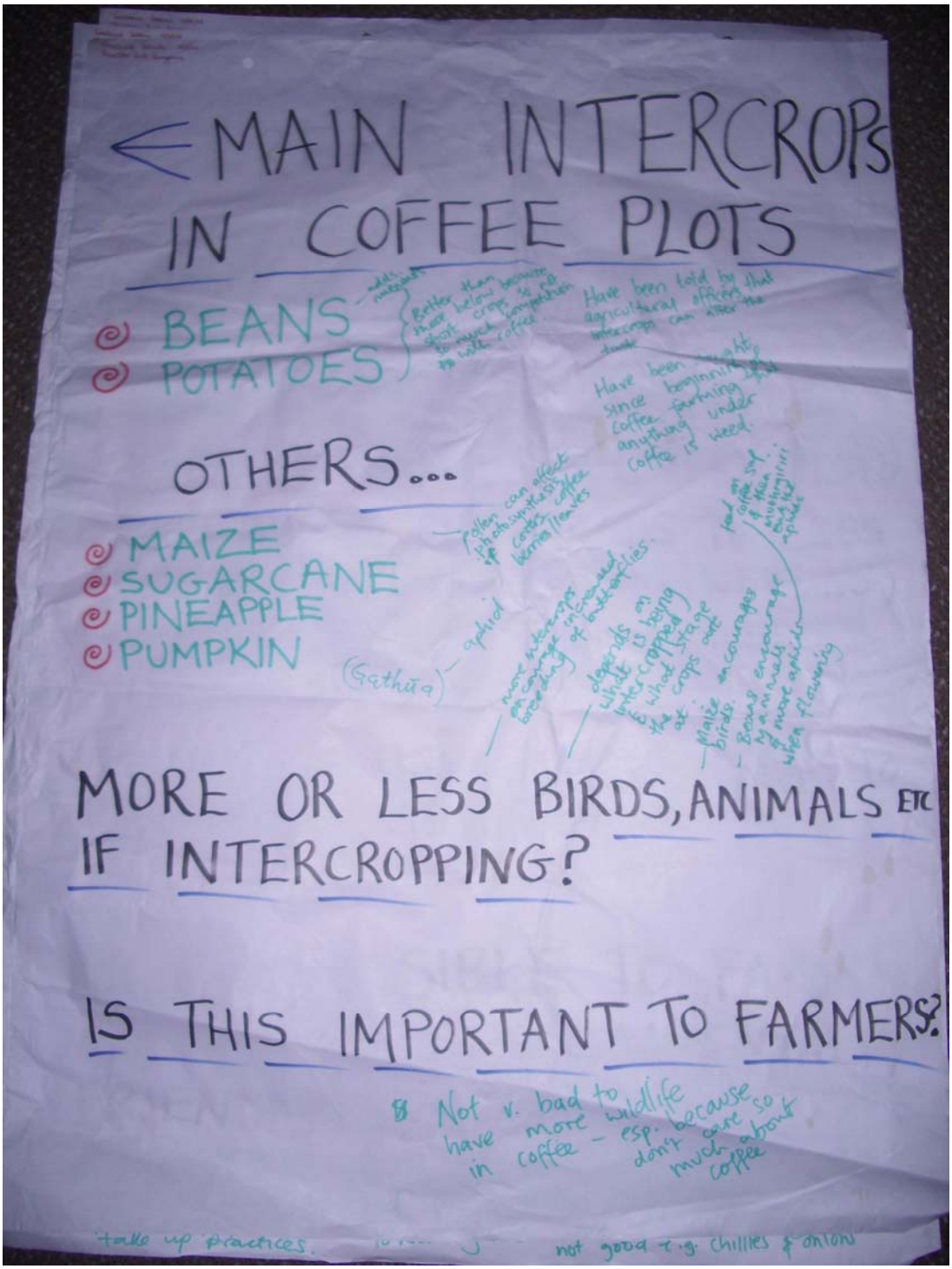
December - start ripening (apply NPK 17:17:17 to prepare coffee for January)

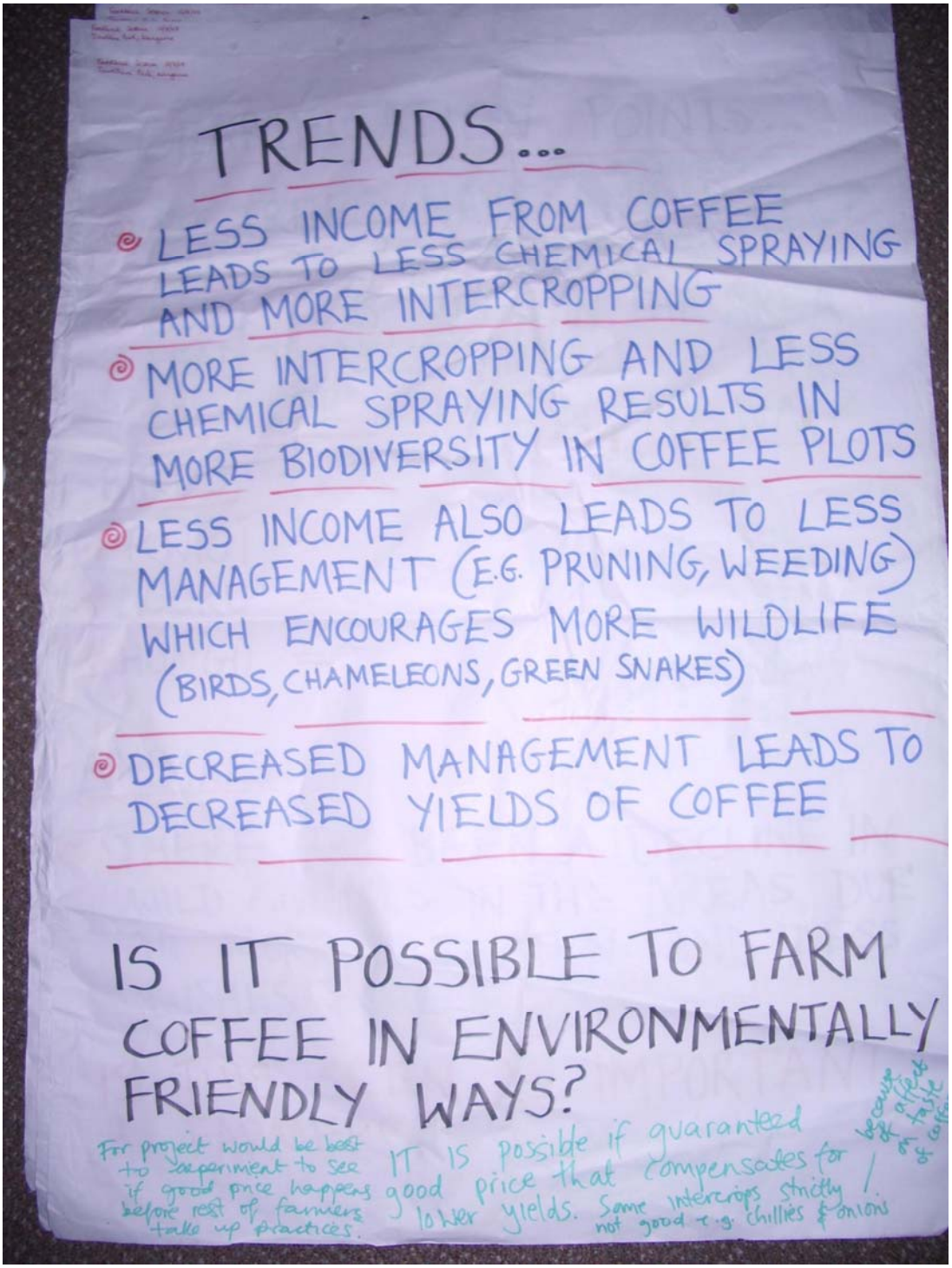
January – major pruning of old branches

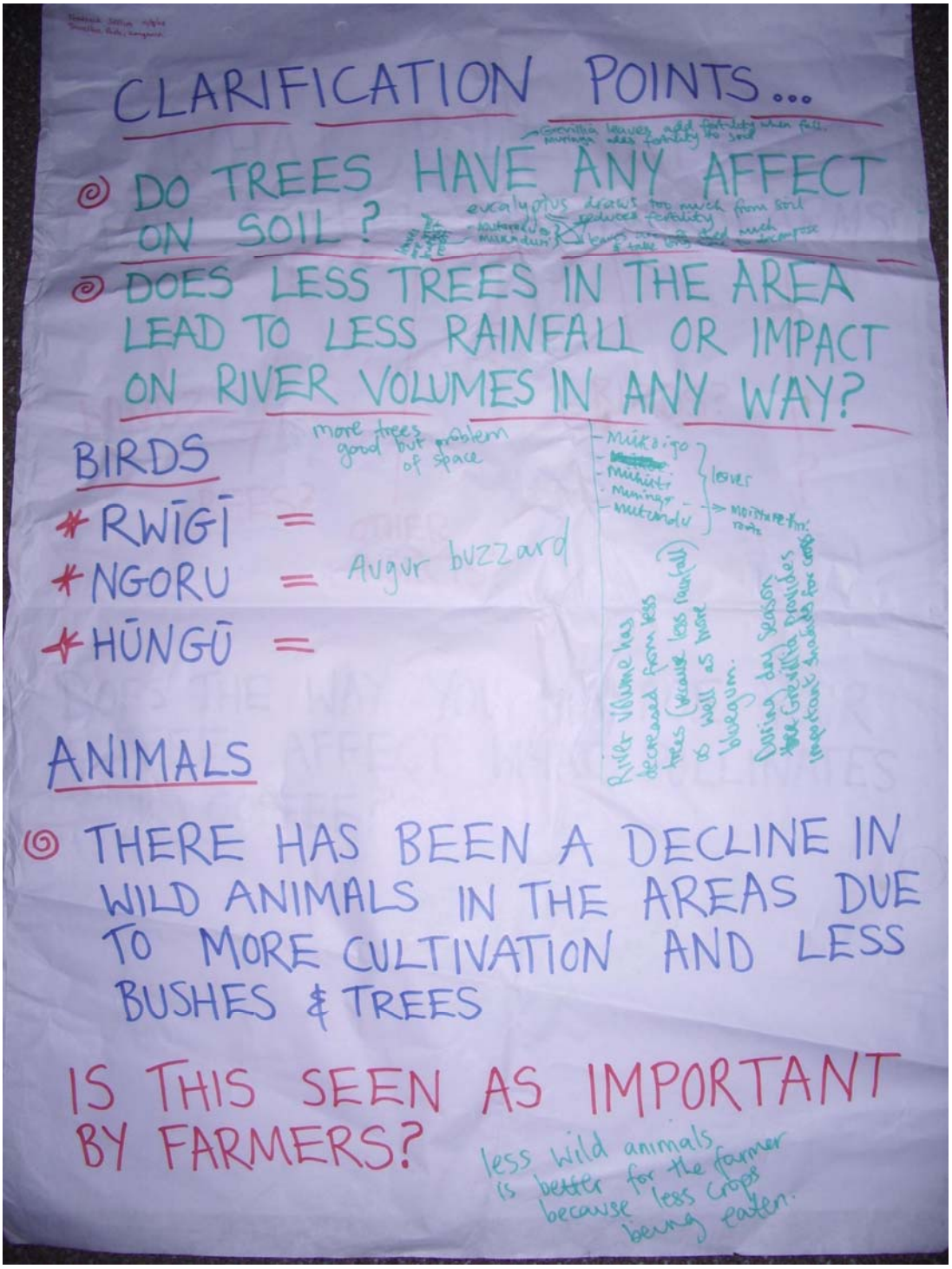
February – process starts again

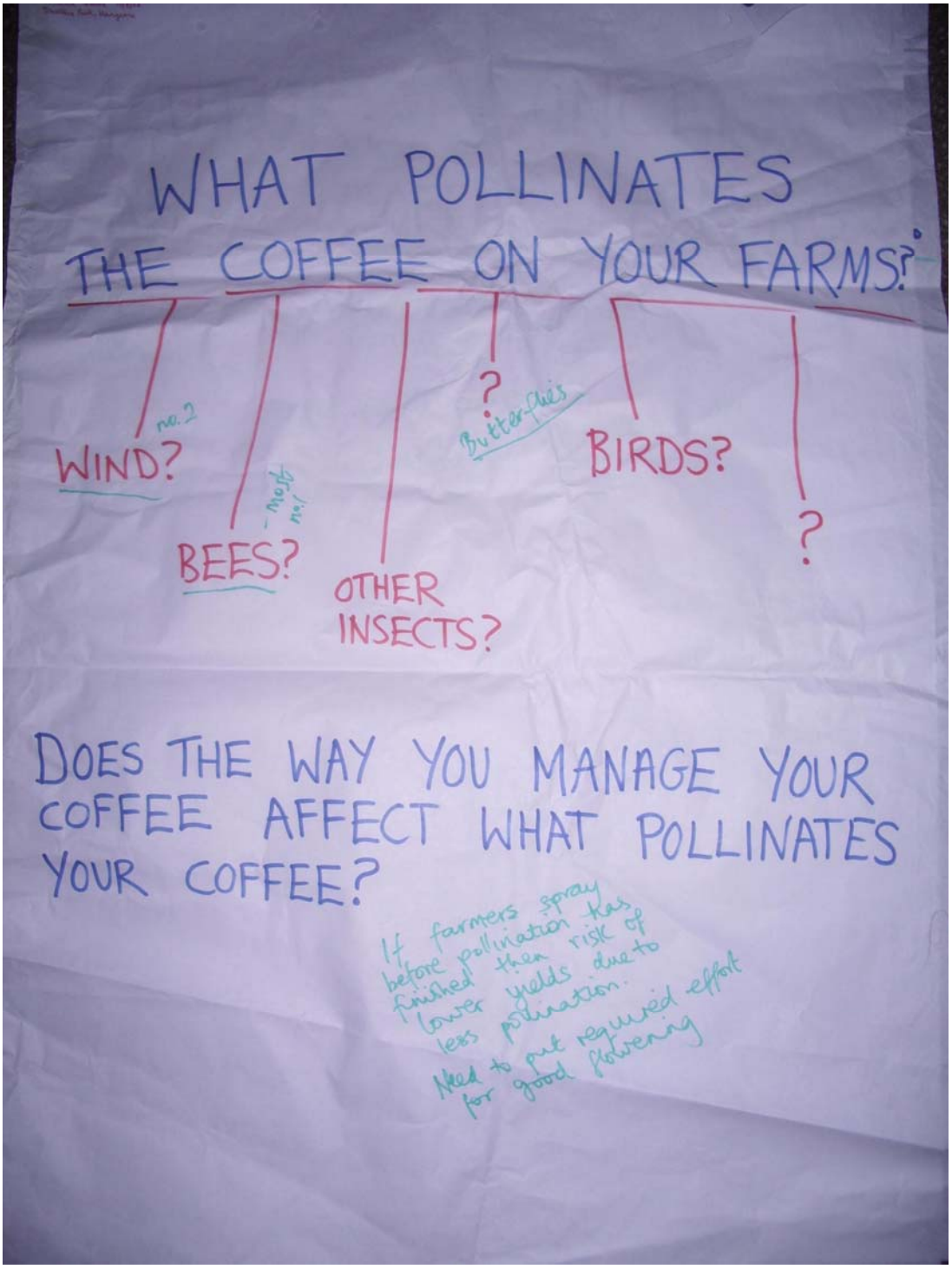
Uses knapsack sprayer.

Appendix 6: A sample of the sheets used at the feedback sessions, with comments from farmers written on




TRENDS...
LESS INCOME FROM COFFEE LEADS TO LESS CHEMICAL SPRAYING AND MORE INTERCROPPING
MORE INTERCROPPING AND LESS CHEMICAL SPRAYING RESULTS IN MORE BIODIVERSITY IN COFFEE PLOTS
LESS INCOME ALSO LEADS TO LESS MANAGEMENT (E.G. PRUNING, WEEDING) WHICH ENCOURAGES MORE WILDLIFE (BIRDS, CHAMELEONS, GREEN SNAKES)
DECREASED MANAGEMENT LEADS TO DECREASED YIELDS OF COFFEE
IS IT POSSIBLE TO FARM COFFEE IN ENVIRONMENTALLY FRIENDLY WAYS?
For project would be best to experiment to see if good price happens before rest of farmers take up practices.
IT IS possible if guaranteed good price that compensates for lower yields. Some intercrops strictly not good e.g. chillies & onions
because affect taste of coffee


CLARIFICATION POINTS...
DO TREES HAVE ANY AFFECT ON SOIL?
DOES LESS TREES IN THE AREA LEAD TO LESS RAINFALL OR IMPACT ON RIVER VOLUMES IN ANY WAY?
BIRDS
more trees good but problem of space
*RWĪGĪ =
*NGORU = Augur buzzard
*HŪNGŪ =
ANIMALS
THERE HAS BEEN A DECLINE IN WILD ANIMALS IN THE AREAS DUE TO MORE CULTIVATION AND LESS BUSHES & TREES
IS THIS SEEN AS IMPORTANT BY FARMERS?
less wild animals is better for the farmer because less crops being eaten.


WHAT POLLINATES
THE COFFEE ON YOUR FARMS?
WIND?
no. 2
BEES?
- moth
no.1
OTHER INSECTS?
?
Butterflies
BIRDS?
?
DOES THE WAY YOU MANAGE YOUR COFFEE AFFECT WHAT POLLINATES YOUR COFFEE?
If farmers spray before pollination has finished then risk of lower yields due to less pollination.
Need to put required effort for good flowering


FUTURE CONCERNS
ABOUT COFFEE FARMING.
- High yields
- money - increase is needed
(9) - Good markets
- Quality - could result in better payments

Appendix 7: Brochure that was disseminated to coffee farmers that participated in interviews and the feedback sessions

The best way of understanding and improving coffee farming is to talk with the farmers.

WHY THE INTERVIEW ?

To collect information on:

1. **Knowledge** of coffee farming.

Kukusanya habari kuhusu ukuzaji wa kahawa.

2. Impacts of different coffee farming practices on the **environment**.

Matokeo ya njia tofauti za ukulima wa kahawa kwa mazingira

3. Farmers' perceptions of coffee **marketing**.

Matarajio ya wakulima kuhusu uuzaji wa kahawa.

WHY IN CENTRAL PROVINCE?

The central region of the Kenyan highlands is where coffee is widely grown. Furthermore Central Province holds a wide range of different types of coffee farms, from small holders to large scale holders.

Mkoa wa Kati ni eneo la sehemu za juu za Kenya abapo kahawa hukuzwa kwa wingi. Mkoa wa Kati pia kuna wakulima wenye mashaba madogo na makubwa.

LET US INTRODUCE ...

... THE TEAM

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WHAT IS ICRAF?

International **C**entre of **R**esearch in **A**gro**F**orestry

Kituo cha kimataifa cha kufanya utafiti wa misitu na ukulima

WHAT IS CAFNET?

Coffee **A**gro**F**orestry **Net**work

Kahawa na mazingira.

Objectives *(Nia):*

- To understand environmental benefits in coffee production

  Kuelewa kuhusu mazingira na manufaa ya ukuzaji wa kahawa

- To strengthen access to information on coffee management.

  Kuboresha ufahamisho wa ukuzaji wa kahawa.

Locations (*Katika*):

- East Africa
- Central America
- India

Duration *(Wakati):*

- Started in June 2007
- Whole program: 4 years
- Interviews: June to August 2007

HAVE SOME QUESTIONS?

Please contact a member of the team with the contacts mentioned inside this brochure.

HOW TO CONTACT ICRAF

- Write to:

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U. N. Avenue
PO Box 30677 | Nairobi | Kenya

- Phone: 254 2 524000
- Fax: 254 2 524001
- Email:

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Dr F. Pinard: f.pinard@cgiar.org

CAFNET is working in partnership with KENVO, CRF and CIRAD in East Africa.

Thank-you for your participation, we look forward to being in touch with you.

World Agroforestry Centre

TRANSFORMING LIVES AND LANDSCAPES

CAFNET Project

Kuunganisha,
kudumisha na kuimarisha uhusiano
kati ya
ubora na uuzaji wa kahawa
na
mazingira

INTERNATIONAL CENTRE FOR RESEARCH IN AGROFORESTRY (ICRAF)

Appendix 8: Causal diagram generated by Kenya KB, representing farmers knowledge of influences on the productivity of their coffee. Symbols are the same as explained in Figures 4.5 and 4.6 in results chapter