Risk and Coffee Production in Mhaji, Tanzania

By

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Preface

The research for this thesis was performed during my service as a Peace Corps volunteer in Tanzania from December 1998 to December 2000 as a part of the Loret Miller Ruppe Master's International program. I served as an agroforester in the Community Based Natural Resources Management project in Mhaji village, Njombe District. This project had a number of specific goals concerning the improvement of resource management in the communities where volunteers were placed, but the volunteers were given a lot of independence in advancing toward those goals. That is, we were more or less told, "Find something to do that fits within the project and do it."

About three months into my service, I was visited at my site by the project director, Israel Mwasha. At that point I had begun to do a number of small projects, but I had not found anything to do that involved agroforestry. Mwasha suggested that I investigate working with the few farmers who were growing coffee. That was a better idea than any that I had had myself, so I decided to give it a try.

I was very fortunate in my timing. The day before I had planned a trip to Njombe town to visit the District Coffee Officer, Samson Lwendo, he came to Mhaji to hold a meeting for those farmers interested in growing coffee. I had to leave this meeting early, and planned to try to get a list of those farmers who had attended. Before I could do this, my Counter Part, Manase Sikauki, came to my house with that very list. Before long, my coffee project, as I came to think of it, was up and running, and I had not only a Peace Corps project, but something to research for my thesis.

I have to admit that when I began the project I was a bit skeptical about promoting coffee. I assumed that if there were any money to be made growing coffee, then the Tanganyika Wattle Company would already be making it, and they were growing tea. The more I learned about coffee and its potential, however, the more I began to believe that it could be a valuable addition to the farming system in Mhaji, and the happier I was that I had gotten involved with it.

I hope that coffee has truly taken root in Mhaji and that it does in fact help to improve the farming system in Mhaji and the lives of the farmers there. I also hope that this research can add to the understanding of how farmers make decisions concerning crops and through this help to improve the methods of coffee promotion and extension in Mhaji and elsewhere.

Acknowledgments

As with all the students who have been a part of the Loret Miller Ruppe Peace Corps Master's International program, I owe a great debt to my advisor, Dr. Blair Orr. He has put together a wonderful program, and he runs it well. He provided irreplaceable support both in Tanzania and Michigan. Without him I would not have accomplished as much as a Peace Corps volunteer, and I might never have finished this thesis. I owe him a special thanks for putting up with me for so long. I would like to point out, however, that he never provided the Land Rover I asked for. I guess no one is perfect.

I would also like to thank the other members of my graduate committee, Kathy Halvorsen, Joe Heyman, and Dave Reed. They gave me valuable advice and encouragement while I was writing.

I must thank a number of people in Tanzania. Israel Mwasha, Peace Corps's APCD for the environment sector, got me started with coffee and provided a wealth of information concerning coffee and Tanzania. Primus Kimaryo at the Tanzania Coffee Board and the researchers and instructors at the Lyamungu and Ugano Coffee Research Institutes gave me the foundation of my knowledge of coffee marketing and the technical aspects of coffee production.

I can not express how much I owe to the people of Mhaji. It may be a cliché to say that they gave me much more than I could ever have given them as a PCV, but it is true. I know that I will always have many friends and a second home there. In particular, I must thank my Manase Sikauki, Counter Part, Milton Wikunge, and Mwalimu Mhomisole; they were not only a great help to me in my life in Mhaji, they were also great friends.

My parents, of course, also deserve thanks. They have always been supportive of everything I've done, and have made most of it possible. Some day I'll get a paying job so I can support them in their old age, but they'll have to live with my sister.

Finally, I want to thank Jenny. Without her love and encouragement I would not have made it through the rougher parts.

Chapter One: Introduction

Smallholder farming in the tropics is a risky business. Farmers face a variety of environmental hazards from drought to floods. In much of the tropics declining soil fertility is also a problem for farmers. These problems are usually exacerbated by unfavorable terms of trade, volatile markets, and expensive agricultural inputs. Farmers pursue various strategies to minimize the risk posed to their livelihood by these hazards. They also, however, sometimes make risky choices in order to increase their income. Risk is not the only factor farmers consider when making decisions concerning their farms and households, but in many cases risk is the primary consideration.

This study is concerned with risk, crop decisions, and coffee in Mhaji, a village in the Southern Highlands of southwestern Tanzania. Coffee is a relatively new crop in Mhaji; a few farmers have grown coffee since the mid-1980s, but the majority of those who grow coffee have decided to do so since 1998. Coffee has the potential to raise the productivity of the farming system in Mhaji and to increase its sustainability. Therefore, it would be valuable to know why farmers decide to grow coffee or some other crop. This paper investigates the role of risk in this decision process.

Coffee can act as a form of risk alleviation primarily by diversifying a farmer's farming system. Coffee is not susceptible to the pests and diseases common to other crops in the area, and it therefore would not be affected by outbreaks that could destroy other crops. Coffee is more drought resistant than other crops grown in the study area; even in a year too dry to produce a traditional field crop at all, a small coffee harvest might be possible. Because coffee is sold internationally, the coffee market is quite different from other cash crops' in the area. Therefore, growing coffee in addition to other cash crops can reduce the risk of market fluctuations. By planting a permanent crop like coffee a farmer can reinforce his tenure of a field, both legally and in the customary system, reducing the risk that someone else might claim the land.

Growing coffee can still be a risky venture for farmers. Because coffee is new to the village, farmers can not be certain how coffee will perform. Farmers also are unfamiliar with the skills involved in cultivating coffee, and there is the risk that they might do something to damage the crop before they learn how to care for it properly. The coffee market is unfamiliar, and because coffee is not marketed locally it is more difficult for farmers to predict prices. Because coffee is a permanent crop, farmers lose some flexibility in managing their farms and might not be able to react to changes in the market. Coffee's lack of food value means that if a farmer is unable to sell his coffee crop his investment in the crop that year will be a total loss. All of these risks are magnified by the large initial investment of labor, time, and cash; a failure would be very expensive.

Farmers must weigh all of these factors when calculating the risk involved in beginning coffee cultivation. They must then decide if that risk is worth taking given the potential benefits of coffee. The goal of this research is to shed some light on this process of risk evaluation and to identify what factors are most influential in farmers' perception of the risk of coffee and how this affects their crop choices.

The next two chapters provide the geographic, climatic, social, and agronomic context framing the study. Chapter two presents background information concerning the history, geography, climate, and culture of Tanzania and the study area. The chapter concludes with a description of the farming system in the study area. Chapter three presents general information about coffee and concludes with a discussion of what role coffee can play in increasing and sustaining the productivity of the farming system in Mhaji. Chapter four provides the theoretical context in which the study was performed. The chapter begins with a discussion of the definition of risk that will be used in this paper. This is followed by a discussion of various theories concerning risk and its role in shaping farmers' decision-making process. Chapter five presents the methods used in the study. In chapter six the results are presented and discussed. The final chapter consists of conclusions and recommendations for further study and for future coffee promotion and extension programs.

Chapter Two: Tanzania, Njombe, and Mhaji

This chapter describes the geographic, climatic, social, and agronomic context within which the study is set. The description begins broadly, providing brief overviews of the geography, history, and culture of the entire country. This may seem to provide a great deal of information that is not relevant to the topic of coffee production in Mhaji. However, this broader context is important in understanding how Mhaji relates to Tanzania as a whole and the rest of the world. This relationship is relevant, as it is important in understanding the roles that risk and coffee production play in Mhaji.

Tanzania

Geography and Climate

Tanzania, the largest of the three countries in East Africa (Kenya, Tanzania, and Uganda), is located between 1° and 12° south latitude and between 29° and 41° east longitude (Figure 1). It is bounded by Kenya and Uganda to the north; Rwanda, Burundi, and the Democratic Republic of Congo to the west; Zambia, Malawi, and Mozambique to the south; and the Indian Ocean to the east. Tanzania consists of two parts: the mainland and Mafia island, formerly Tanganyika, and the Zanzibar archipelago, which includes Unguja, commonly referred to as Zanzibar, and Pemba, as well as several smaller islands. Mainland Tanzania has an area of approximately 378,000 square miles, about twice the size of California; Zanzibar covers about 640 square miles (US Department of State 2000).

Figure 1. East Africa (CIA 2000).

Geographically, the most striking aspect of Tanzania is its great variety (Figure 2). Altitude ranges from sea level to over 19,000 feet at Mount Kilimanjaro, the highest point in Africa, and topography varies from flat coastal plain to the escarpments of the Great Rift Valley. The country can be roughly divided into six geographic categories: the islands, including both Zanzibar and Mafia, the coast and the deep south, the central plateau, the Eastern Arc mountains, the highlands of the north and south, and the Great Lakes. The islands are low and flat and are bounded by coral reefs. Low, flat plains also characterize the coast and the deep south. However these plains rise steadily toward the interior, particularly in the south which also contains the relatively high Makonde Plateau. This region is also marked by the Ruaha-Rufiji and Ruvuma river systems and the ports of Dar es Salaam and Mtwara. Rising from the coastal plains are the isolated ranges of the Eastern Arc mountains. This chain of mountain ranges extends from southern Kenya to the edge of Tanzania's Southern Highlands, and they are known for their remarkable biodiversity and levels of endemism. The central plateau is higher than and not as flat as the coast; it is also cut by the steep valleys and escarpments of the rift valley. In northern and southwestern Tanzania are extensive highlands, high plateaus marked in the north by volcanic peaks such as Kilimanjaro, Meru, and Oldonyo Lengai, and in the south by the Livingstone and Kipengere ranges. Finally, the western edge of Tanzania is defined by the Great Lakes of Victoria, the source of the Nile River, Tanganyika, and Nyasa, known as Lake Malawi outside of Tanzania.

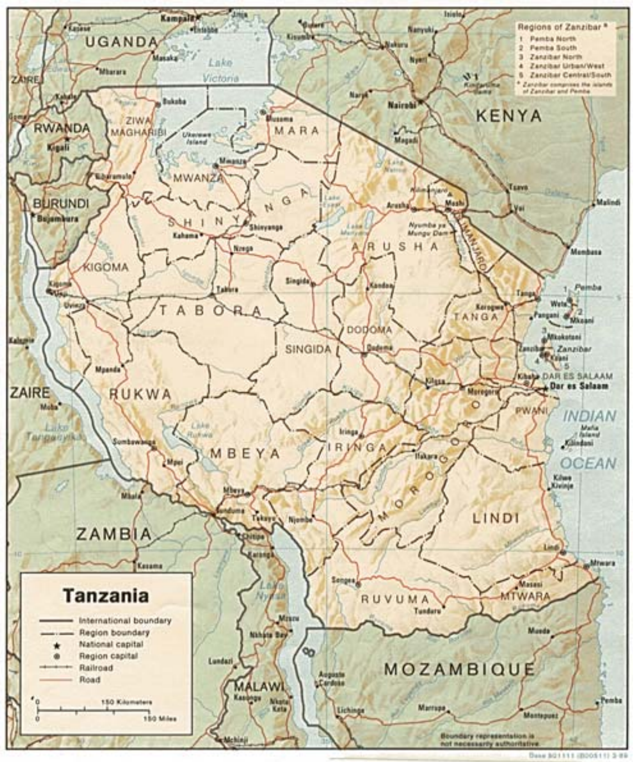

Figure 2. Tanzania (CIA 2000).

Tanzania's climate is as varied as its geography. Temperatures range from extremely hot in the coastal lowlands and along the Great Lakes to cooler but still tropical on the central plateau and in the upper elevations of the Eastern Arc ranges to sub-tropical in the northern and southern highlands, and it can be quite cold at the top of Kilimanjaro. Rainfall also varies widely. There are two distinct rainfall patterns. In the north and along the northern coast rainfall is bimodal with the "long rains" (*masika*) lasting from March until May and the "short rains" (*vuli*) lasting from October through December. In the rest of the country rainfall is unimodal, lasting from December until April. Within these regimes there is significant variation in the timing, amount, and distribution of rainfall. In general, the northern and central parts of the country tend to be more arid, while the coast, the islands, the Southern Highlands, the deep south, and the various mountain ranges have abundant precipitation (United Republic of Tanzania 2001).

Economy

Tanzania is rich in natural resources, but it is one of the poorest nations in the world. There are abundant mineral resources, including gold, diamonds, the world's only Tanzanite mine, and other precious and semi-precious stones, as well as under-explored and unexploited fossil fuel reserves (United Republic of Tanzania 2001, CIA 2000). Forest resources include many valuable timbers including African and Ethiopian mahogany (*Khaya anthotheca* and *Trichilia emetica*), African cedar (*Juniperus procera*), ebony (*Diospyros* spp.), and podocarpus (*Podocarpus* spp.) (Mbuya, *et al* 1994, Hines and Eckman 1993). The Indian Ocean and the Great Lakes, particularly Lake Victoria, contain significant fisheries resources. Zanzibar, Mount Kilimanjaro, and Tanzania's wildlife reserves, including Serengeti and Gombe Stream National Parks and the Ngorongoro Crater Conservation Area, attract large numbers of tourists (United Republic of Tanzania 2001). However, the most important natural resource is agricultural land.

Although topography and climate limit agriculture to only four percent of Tanzania's land (CIA 2000), agricultural production is vital to Tanzania's economy. Agriculture is variously reported as accounting for 50 percent (CIA 2000) to 60 percent (U.S. Department of State 2000) of Tanzania's Gross Domestic Product. Ninety percent of the workforce is employed in agriculture. Eighty-five percent of Tanzania's exports are agricultural products. The major agricultural exports are coffee, cotton, tea, tobacco, cloves, sisal, and cashews (CIA 2000). However, in spite of this dominance of agriculture in the national economy, production levels are far below their potential and significantly lower than they were in the recent past (Ekpere, *et al* 1992).

Despite its potential natural wealth, Tanzania remains one of the poorest nations in the world. The official government figure for per capita income in 2001 is $251 (United Republic of Tanzania 2001). Figures from other sources for 1999 cover a relatively wide range: the European Union (1999) reports $125, The United States Department of State (2000) $260, and the Central Intelligence Agency (2000) $550. One figure that all these sources agree on is that roughly half of Tanzania's people live below the poverty level of one dollar per day.

People and Culture

Tanzania has a population of approximately 35 million people (United Republic of Tanzania 2001). The distribution of population is very uneven. On the mainland, rural population density ranges from one person per square kilometer in the more arid areas to 51 people per square kilometer in some of the very productive highland areas; in some areas of Zanzibar population density can reach as many as 134 people per square kilometer (US Department of State 2000). The infant mortality rate is between 80 and 85 per 1,000 live births (CIA 2000, European Union 1999). With the recent rise in deaths caused by AIDS, life expectancy has dipped to approximately 50 years, and is expected by some to sink even lower (CIA 2000, European Union 1999, US Department of State 2000).

The vast majority, 99 percent (CIA 2000), of Tanzanians are indigenous Africans (Figure 3). There are more than 120 indigenous ethnic groups (US Department of State 2000), and depending on how they are defined there may be more than 130 (CIA 2000). Ethnic groups in Tanzania are generally defined by language groups, but other criteria are considered important by some anthropologists, and even the seemingly simple grouping by languages can sometimes be ambiguous. The remainder of the population is made up of people of Arab, Asian, primarily Indian and Chinese, and European descent (CIA 2000). If both the mainland and Zanzibar are considered, there are equal numbers of Christians and Muslims, each 45 percent of the population, and a much smaller number of people with indigenous beliefs (US Department of State 2000). However, this is somewhat misleading. On the mainland 45 percent of the population is Christian, 35 percent Muslim, and 20 percent have indigenous beliefs, while Zanzibar is at least 99 percent Muslim with the final one percent split among other religions (European Union 1999, CIA 2000). These statistics ignore groups such as Hindus, Sikhs, and Rastafarians which, while small, are present, particularly in Dar es Salaam and some larger towns.

Figure 3. The Majority of Tanzanians are of African descent.

Tanzania has two official languages. Swahili (*Kiswahili*) is taught in primary schools and is the language of daily use for many Tanzanians. English is the primary language of commerce and administration and is the official language of secondary and higher education. Arabic is widely spoken in Zanzibar, along the coast, and in other areas with strong Arab and Islamic influences. The first language of most Tanzanians, however, is the local language of his or her ethnic group. In addition, there are people who speak various Indian, Chinese, and European languages other than English.

History

The human history of what is now Tanzania is as long as that of any other region. There are archaeological sites in Tanzania, including the famous Ol Duvai gorge, which have provided some of the oldest evidence of hominid evolution. The pre-colonial history of Tanzania is, therefore, quite long, and it is difficult to generalize about the development of the numerous cultures. However, there are a few characteristics that were common to many indigenous ethnic groups prior to colonization. With few exceptions, primarily in some highland areas, throughout most of Tanzania people lived in dispersed communities. Households were separated by relatively large areas of fields and bush fallow. This was particularly true in areas where unmodified bush provided habitat for tsetse fly and trypanosomiasis was a problem. Localized industries were also common, for example salt and iron production, and these industries were usually integrated with some regional trade system. Conflict among tribes and among communities within tribes was common, although just how common this was is open to some debate (Iliffe 1979, Kjekshus 1996, Kimambo 1996).

The first outside influence on Tanzania and the rest of East Africa was Arab. Arab settlements existed on Zanzibar and the mainland coast as early as the eighth century. By the twelfth century the trade in ivory and slaves had become significant (U.S. State Department 2000). This trade was important both in the demographic effects of the slave trade and in the further development of trade, particularly the establishment of caravan routes which served to strengthen and expand existing, more localized trade routes. These caravan routes still exist, in a way, as the Northern and Central Railways follow roughly the same paths. While the Arab settlers and traders affected the people and cultures of Tanzania, they did not try to govern areas beyond their trading centers, and they made no effort to centralize what control they did have over these areas (Kjekshus 1996). German colonizers, however, were different.

The German colonialists were not the first Europeans to reach East Africa. The Portuguese had established scattered outposts and had claimed control of the entire eastern coast of Africa without, however, enforcing the claim, and a number of missionaries and explorers had arrived in Tanzania prior to German colonization (US State Department 2000, Iliffe 1979). However, the impact of German policies in Tanzania was much more dramatic than any previous European influence. The German

East Africa Company was founded in 1884 by Karl Peters. By 1885, Peters had negotiated some treaties of dubious legality that ceded most of the mainland to his company and the Kaiser. Zanzibar remained under the control of Omani Arabs and eventually became a British protectorate. German military actions to “pacify” the native tribes began in 1888 and continued through the Maji-maji wars which ended in 1907 (Iliffe 1979, Kjekshus 1976). In many of these actions, the Germans pursued a “scorched-earth” policy that exacerbated the loss of life caused by direct conflict. At the same time, German colonial officials levied heavy taxes and recruited or coerced large amounts of African labor for construction of roads, railroads, and settlements and for agricultural work on colonial plantations. These policies coincided in the 1890’s with outbreaks of diseases, notably rinderpest among livestock and smallpox among people, and a series of widespread crop failures and famines. As a result, by the early 1900’s the native Tanzanian cultures had been severely disrupted (Kjekshus 1996).

German control over mainland Tanzania ended with the First World War. During the war a fair amount of fighting took place in mainland Tanzania. British and Kenyan troops spent much of the war chasing German guerillas who lived off the land, that is by raiding African farms (Iliffe 1979). As Kjekshus (1996) says, “it is quite evident that the people of Tanganyika bore the brunt of this campaign” (151). After the war, Tanganyika was made a League of Nations Mandated Territory with the administrative mandate given to Great Britain (US Department of State 2000). At first, Tanganyika was relegated to the periphery of Britain’s African colonies, and its development was given a lower priority than Uganda, Kenya, and the colonies of southern Africa. Consequently, there was little effort put into development of infrastructure, and there was little immigration of Europeans compared to other colonies (Iliffe 1979).

The British administration established a system of indirect rule, appointing Native Authorities who ruled through a hierarchy based on existing native rulers. These hierarchies were often based on misinterpreted, altered, or imposed “native” systems that fit British preconceptions and the needs of the policy of indirect rule. Much of British policy was geared toward controlling disease and regulating native agriculture; these included consolidation of settlements to control sleeping sickness, mandated minimum crop acreages to ensure a desired level of production, and various soil conservation measures. Another focus of British policy was the production of timber, which included the creation of forest preserves and the introduction of plantations of exotic species. Game preservation was also emphasized (Iliffe 1979, Maack 1996, Wagner 1996).

After World War Two, Tanganyika became a United Nations trust territory, again under British control (US Department of State 2000). This changed little in British policy. However, after the war there was a growing sense of nationalism among Tanzanians. In 1954 the Tanganyika African Nationalist Union (TANU) was formed. Under the leadership of Julius K. Nyerere, TANU gained influence in the colonial government and pressured the British to increase Tanganyika’s autonomy. In 1961, Tanganyika became autonomous, and later that year it gained full independence. Nyerere was elected the nation’s first president. In late 1963, Zanzibar gained its independence from Great Britain, and in January 1964, the African majority revolted and overthrew the Arab-dominated government. On April 26, 1964 Tanganyika and Zanzibar united to form the United Republic of Tanganyika and Zanzibar with Nyerere president; later that year the name was changed to the United Republic of Tanzania (Iliffe 1979).

Six years after Independence, in 1967, Nyerere released the Arusha Declaration. This document directed the government to make Tanzania socialist and self-reliant. This socialism was to be an African socialism, rather than one imported from elsewhere, and it came to be known as *Ujamaa*, a Swahili word normally translated as "familyhood" (Nyerere 1970). The hallmark of this African socialism was the policy of Villagization or "Operation *Kijiji*" (village). Villagization was the consolidation of scattered households in *Ujamaa* villages where villagers would participate in large-scale communal agriculture and have easy access to services such as schools and medical facilities. While this policy looked good (to some) on paper and enjoyed limited success in some areas, on the whole it was unsuccessful, and eventually abandoned (Hyden 1980). Beginning in 1986, Tanzania has moved to liberalize its economy through a series of structural adjustment programs. In conjunction with this, Tanzania has abandoned its one-party system and since 1990 has been a multi-party democracy, and this transition has been largely successful. However, the ruling Chama Cha Mapinduzi (CCM, Party of the Revolution) has been regularly accused of fraud during elections in Zanzibar (US Department of State 2000).

Njombe

Geography and Climate

Njombe District is located in Iringa Region in southwestern Tanzania (Figure 4). This part of Tanzania is generally known as the Southern Highlands, because it is characterized by high plateaus and several mountain ranges. The largest part of Njombe District is the Njombe High Plateau, with altitudes reaching 2,000 to 2,400 meters above sea level. This plateau is relatively flat, but throughout it is cut by steep-sided valleys, many of which contain perennial streams. In the northwest is the Makambako Gap, a slightly lower area separating the Njombe plateau from the Mafinga plateau to the north. The western edge of the district rises to the Kipengere range which extends beyond Njombe's boundaries. Near the eastern and southern boundaries of the district, the plateau drops off towards the Kilombero River valley and the lower plains of the Deep South, respectively.

All of Njombe falls within the part of Tanzania which has a unimodal rainfall pattern. The rains begin in mid to late November and continue until late April, with the heaviest precipitation coming from January through March. Most of the district receives adequate rainfall (1,000 to 1,500 mm per year), but the lower, northwestern areas are considerably drier. The effects of the long dry season are mitigated somewhat by frequent mists in many areas. Higher altitudes are cool (Tanzanians consider Njombe one of the coldest parts of the country), and frost is common in some areas in June and July. Lower altitudes are, of course, warmer. Because of the many steep valleys, in many areas a wide range of temperature regimes can be found in a relatively small area.

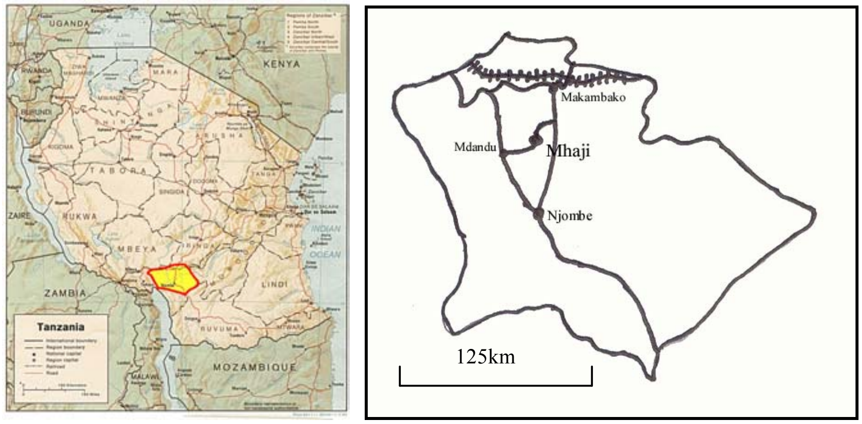

Figure 4. Njombe District is located in Southwestern Tanzania (CIA 2000, Adapted from Shand 2001).

Njombe is blessed with relatively good transportation. The Tanzam Highway and Tazara Railway cross northern Njombe on their routes from Dar es Salaam to Lusaka, Zambia. The town of Makambako is located at the junction of the Tanzam Highway and the Songea road. Both of these roads are paved, and therefore there is easy transport from Njombe town and Makambako to Dar es Salaam, Songea, and the Malawi and Zambian borders. Secondary roads throughout the district are of much lower quality, but most of the district is within one day's travel from either Makambako or Njombe.

People, Culture, and Economy

The vast majority of the people in Njombe are Bena; small numbers of other tribes are native to parts of Njombe, most notably Hehe and Kinga. The two major towns in the district, Njombe and Makambako, are more ethnically diverse, as is the more arid northwest where numbers of Maasai and other pastoralists have migrated. Njombe is predominately Christian. There are four missions in the district, two Lutheran and two Catholic (one German and one Italian), but many denominations have a presence in the area. There are also some Muslims, as well as many people who practice indigenous beliefs. Practice of Christianity or Islam and indigenous beliefs are not necessarily mutually exclusive.

The Bena are a Bantu-speaking people closely related to the Hehe and the Sangu. In some literature the Bena are considered a sub-group of the Hehe (Mumford 1934). Even the Bena and the Hehe themselves recognize how closely they are related. The origin myths of both tribes state that the tribes are descended from a pair of brothers (Culwick and Culwick 1935). There is a joke among the Bena that the only difference between the two tribes is that the Bena have stopped eating dogs while the Hehe continue to do so. Historically, the Bena have often been dominated by the Hehe, the Sangu, and the Ngoni; however, they had a reputation among their conquerors for being strong fighters and for fiercely resisting (Iliffe 1979, Culwick and Culwick 1935). Consequently, the Bena were allowed to maintain their separate identity rather than being absorbed into the conquering tribes. The Hehe even incorporated a “regiment” of Bena into their military structure (Culwick and Culwick 1935). Traditionally, the Bena have lived in dispersed settlements raising finger millet and large herds of cattle (Mumford 1934, Lucas 1997). Now, millet has largely been replaced by maize and wheat, and the large herds are gone, never replaced after the rinderpest epidemic of 1890 (Lucas 1997, Kjekshus 1996). Historically, the Bena supplemented their agriculture with salt production; much of this salt was traded with the neighboring Kinga for their iron hoes (Kjekshus 1996).

Since the period of German control, Njombe has served as a source of labor for other areas. This began with German labor recruitment, primarily for the sisal estates of Tanga Region. Out-migration became important in Njombe rather quickly, and communities of Bena and Kinga became common in areas with large plantations. Eventually migration destinations even included mining areas of Zambia and Zimbabwe. At times, more than half of the men in some communities in Njombe were working elsewhere either permanently or seasonally. While not as prevalent as it once was, out-migration remains an important factor in Njombe's economy and the lives of the people who live there (Mung'ong'o 1998, Graham 1968).

Outside of Njombe town and Makambako, the primary economic activity is agriculture. Maize is the primary food crop, but many others are also grown, including several varieties of beans, Irish and sweet potatoes, wheat, finger millet, various exotic and indigenous fruits, and several types of indigenous root crops known as "Livingstone potatoes". Cash crops are widespread throughout the district, although they are less common in the drier northwest; they include maize, tea, coffee, Irish potatoes, wheat, tobacco, sunflower, and peas. One rather unusual "crop" of note in the area is *ulanzi*, a local alcohol made from the sap of bamboo and sold throughout the area.

While they also frequently participate in agriculture, the people who live in the district's two towns, Njombe and Makambako, are more likely to depend on other means of income. There are a number of businesses in both towns, including, but not limited to, shops, restaurants, guesthouses, and transportation companies for both passengers and freight. Historically, Njombe has been a source of labor for other regions of Tanzania, and this continues today.

Another important source of income for residents of both the towns and some villages is the Tanganyika Wattle Company (Tanwat). Tanwat as founded in 1949 with help from the Colonial Development Corporation (CDC, now the Commonwealth

Development Corporation) (Nickol 1959). Tanwat owns about 44,000 acres within the district; most of this area is devoted to plantations of black wattle (*Acacia mearensii*), an exotic species grown for tanin, with a significant and growing area of tea plantations and smaller areas of pine (*Pinus patula*) and eucalyptus (*Eucalyptus globulus* and *E. grandis*), grown for timber. Tanwat also owns and operates a tea processing plant, a tanin extraction plant, and a sawmill. Some Bena were forced to move from lands that were granted to Tanwat (Sikauki 1999), and this, combined with the common belief than Tanwat occupies the most fertile areas, has led to some resentment of the company. However, most residents of Njombe seem to have accepted Tanwat and appreciate its contribution to the local economy. With the exception of the theft of small amounts of fuelwood from Tanwat's plantations, there is little conflict between the company and the people.

In 1953, the CDC established the Bena Wattle Scheme. This was a program intended to benefit the people of Njombe by providing them with a cash crop, black wattle, and a market, Tanwat. Under the plan, the CDC would plow and seed large areas. These common plantations would then be divided into one-acre plots and allocated to growers. The growers would be responsible for the cost of plowing and seeding, but any cost beyond their means would be supplied by loans from the CDC. The growers would then care for their plots through the nine-year growing cycle, and then sell the bark, from which tanin is extracted, to Tanwat. Ideally each grower would own at least nine plots of different ages and, after the first nine-year cycle, harvest at least one plot each year (Nickol 1959). The scheme met with some early success (Nickol 1959), but was plagued with problems from the beginning and eventually was abandoned (Sikauki 1999, Mwasha

1999). The most significant problem was the failure of growers to perform necessary tasks in a timely manner, despite pressure from the scheme staff and the Native Authorities (Nickol 1959). This was largely because many of the growers lived some distance from the common plantations, and other crops were usually given a higher priority (Sikauki 1999). The final factor in the demise of the scheme was a dramatic fall in the price that farmers were offered for the bark (Mwasha 1999). Presently, black wattle has become naturalized throughout Njombe, and it is still cultivated extensively by farmers, but only for fuelwood and poles.

Mhaji

Mhaji is located in central Njombe just west of the Makambako-Songea road (Figure 4). This is in the heart of the Njombe plateau, and the main part of the village is located on wide ridges between 1,800 and 2,000 meters above sea level. Most of the village boundaries are marked by small streams and rivers, and other streams drain into these; the lowest of these drainage valleys are approximately 1,700 meters above sea level. On the eastern edge of Mhaji is a wide valley, also approximately 1,700 meters above sea level, containing the Lihogosa Swamp. This area is a grassy marsh that has been flooded and expanded by a dam at its lower end; the dam was constructed by Tanwat, and the swamp is a source of irrigation water for the company's tea plantations, as well as water and fish for Mhaji and the neighboring village of Igima.

The high ridges that make up much of Mhaji are quite flat on top and wide enough in parts to create the illusion of a broad flat plain (Figure 5a). However, the valleys that bound and cut through these ridges are quite steep, often with slopes in excess of 45 degrees (Figure 5b). The valley bottoms in turn are flat, ranging in width from as little as ten meters to several hundred meters and, in the case of the Lihogosa Swamp, several kilometers. The majority of the streams in these valleys flow throughout the year, but a few are intermittent, particularly in drier years.

Figure 5. Mhaji is characterized by flat ridges (5a) separated by deep, steep valleys (5b).

No formal soil survey was performed as a part of this study; however, based on Lucas (1997), Nickol (1959), my observations, and farmers' descriptions of soils, it seems likely that Mhaji's soils are largely oxisols and alfisols, with other soils in smaller pockets. Most of the soils in the village have high clay contents (Figure 6), although there are some areas with very sandy soils, and soils run the gamut from very sandy to very clayey. When asked to classify the soils in there fields, villagers use a simple set of categories: *kawaida* (ordinary), *mzito* or *wa mfinyanzi* (heavy or for pottery), *mchanga* (sand), and *mchanganyiko* (mixture). Further distinction is made by color with categories for ordinary, red, black or dark, and, in some cases, white or light colored. Soils with high organic matter contents are often called *wa msitu*, or of the forest, sometimes regardless of whether they actually come from a forested area.

Figure 6. Even “normal” soils have a clay content suitable for brick making.

There is no climatic data for Mhaji itself, but Tanwat has maintained weather stations for some time. Data are available for the company headquarters located in Kibena, near Njombe town (Tanwat 1995). This is somewhat distant from Mhaji (approximately 25 kilometers), but it is similar in altitude and climate and can provide an approximation of climate in Mhaji. Mean monthly high temperatures range from about 21° C in June and July to about 26° C in October and November, for 1971 to 1994. Mean low temperatures range from 6° C in July and August to 12° C from November through March (Figure 7). Mean annual rainfall from 1985 to 1995 is 1,170 millimeters, but there is a significant amount of variation from year to year (Figure 8). March has the highest monthly mean precipitation at nearly 300 millimeters, with monthly means for January and February above 200 millimeters and December and April above 130 millimeters. Mean monthly rainfall is minimal (less than 15 millimeters) from June through October. November and May, the beginning and end of the rains, have somewhat more rainfall, but still less than 85 millimeters (Figure 9). Relative humidity is often high, and mists and cloudy skies are quite common (Figure 10). As Nickol (1959) says, Njombe often

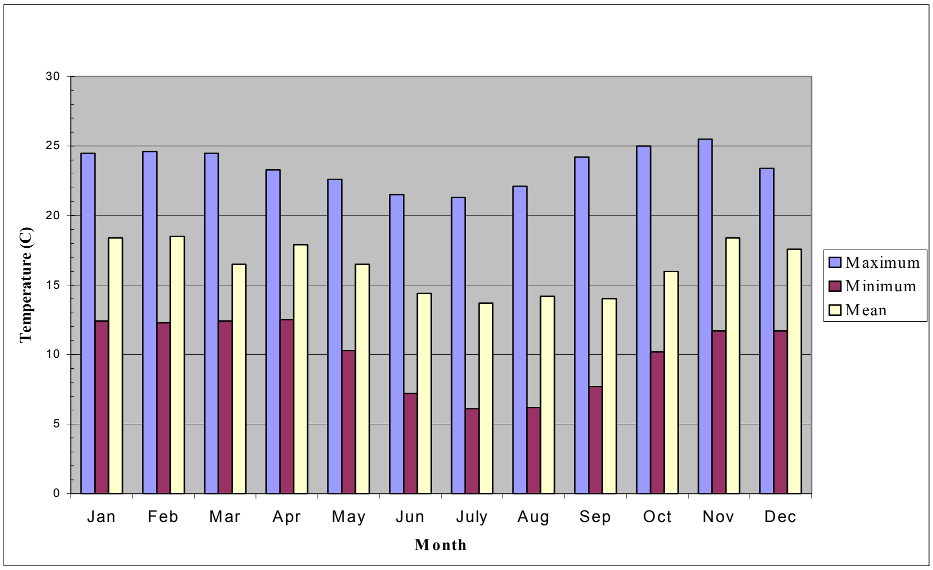

Figure 7. Mean Monthly temperatures, Tanwat Headquarters, Kibena 1971-1994 (Tanwat 1995).

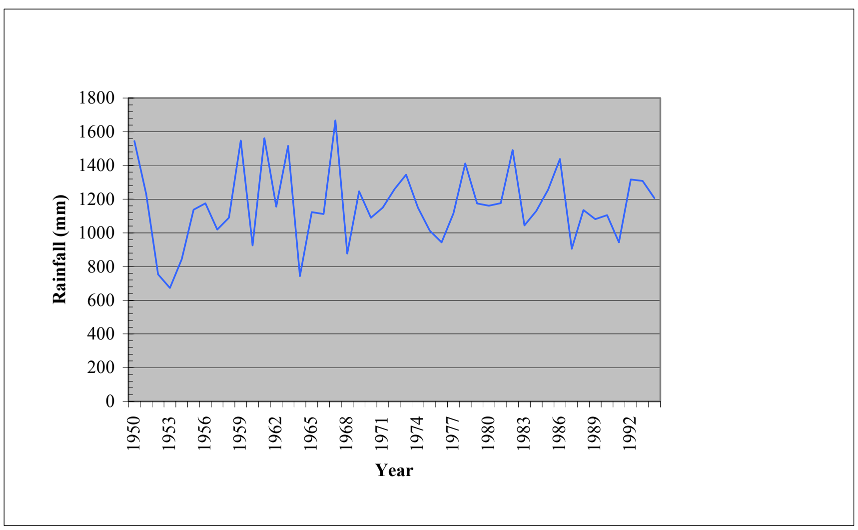

Figure 8. Annual Rainfall, Tanwat Headquarters, Kibena, 1950-1995 (Tanwat 1995).

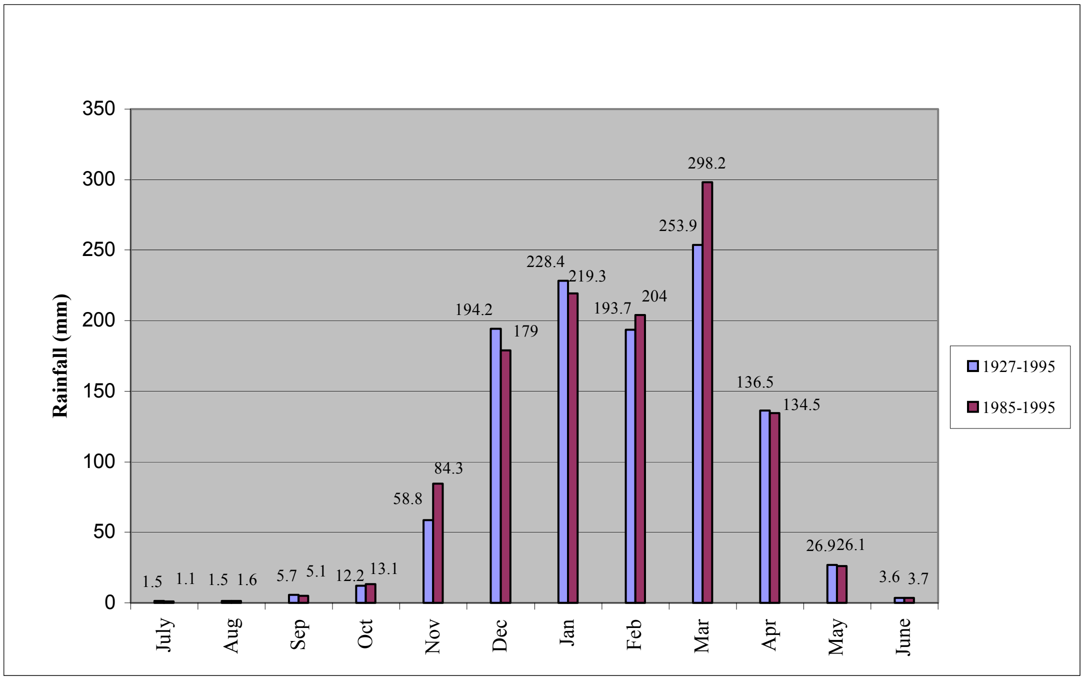

Figure 9. Mean Monthly Rainfall, Tanwat Headquarters, Kibena (Tanwat 1995).

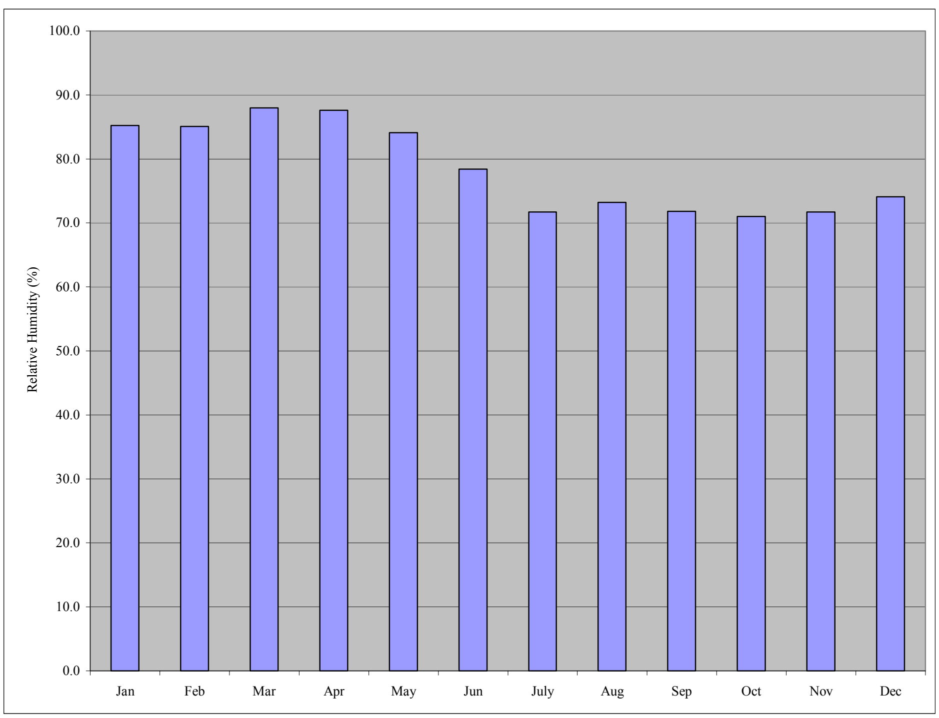

Figure 10. Mean Monthly Relative Humidity, Tanwat Headquarters, Kibena 1971-1994 (Tanwat 1995).

seems “more like the Border country [of England and Scotland] than tropical Africa” (53). Mhaji also experiences frequent steady and often strong winds.

A dirt road passes through Mhaji connecting it with the Makambako-Songea road and with villages farther in from the road. There is access to the paved road on either end of the Lihogosa swamp, and the road is approximately ten kilometers from the center of the village by either route. Two buses pass through Mhaji each day, one to Njombe and one to Makambako. The buses go to the towns each morning and return each afternoon. In the dry season the trip takes between forty-five minutes and one hour; in the rainy season this is considerably longer, and the timetable is less certain. There are bike and foot paths to each town which are shorter. Mhaji’s transportation connections to the rest of the district, and indeed much of Tanzania are quite good. Using public transportation it is possible, with some luck, to reach Dar es Salaam, Songea, or Mbeya near the Malawi and Zambian borders in one day. Transportation within the village is almost exclusively by foot and bicycle, and few “streets” are much more than paths (Figure 11).

Figure 11. The center of Mhaji’s Shuleni subvillage, showing a “street”.

The people of Mhaji are essentially all Bena (Figure 12). There are a handful of non-Bena, most of whom are teachers and government extension agents. The majority of the people are Christian, primarily Lutheran, but with significant numbers of other denominations. There are also many who practice traditional religions and a handful of Muslims. According to a census conducted by the village council in 2000, there are 3,178 "workers" (*wafanyakazi*) in Mhaji, 1,530 men and 1,648 women. "Workers" are residents over 18, that is those who are supposed to be included on the tax roles. In practice, unmarried children older than 18 tend to live with their parents who often misrepresent such children's ages in order to avoid such taxation. These people are reported to live in 795 separate households (Mhaji Village Council 2000). Polygamous families may be counted as one or multiple households depending on whether wives live in a single compound or separate compounds. Houses are scattered over a large area with single houses or small groups of them surrounded by several acres of fields.

Figure 12. Some of the residents of Mhaji (as well as three guests).

Essentially everyone in Mhaji, even those few with full-time salaried employment, is a farmer, and agriculture is the primary economic activity in the village.

Agriculture provides both subsistence and cash income. This production is often supplemented by off-farm income, which includes such activities as employment with Tanwat, shops, restaurants, sale of *ulanzi* and other local alcohol, fishing in the Lihogosa swamp, carpentry and masonry, and other trades (Figure 13). Per capita income is reported at 12,690 Tanzanian shillings per year (Mhaji Village Council 2000). In 1999, one dollar was equal to approximately Tsh 800/=.

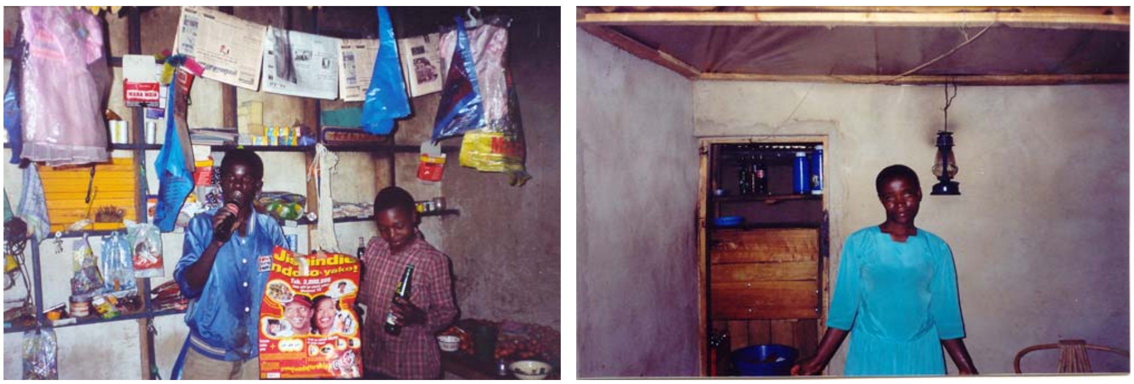

Figure 13. Examples of off-farm income: A shop (13a) and a restaurant (13b).

Farming Systems in Mhaji

The basic farming system in Mhaji is best described as an upland cereal-based system as described by Beets (1990), but with one significant difference. Beets describes the system as "semi-sedentary" until population pressure increases and causes fallow periods to be shortened, forcing the system to become more sedentary (381-382). In Mhaji as in most of Njombe District, population density is not high, and, while land is somewhat scarce (Lucas 1997), the system is much more sedentary than Beets's description would suggest. Fields left fallow seem rare; it appears to be more common for a farmer to plant all his land, even if he is unable to tend all of his fields.

Fields can generally be divided into two types: upland fields (*shamba*, plural *mashamba*) that are primarily rain fed and valley-bottom gardens (*bustani*, plural *bustani*) that are irrigated (Figure 14). Upland fields can further be categorized by their distance from the home and their position on the slope. Lucas (1997) found that at least nine field types are identified by the Bena in eastern Njombe. These distinctions are based on a combination of field location, soil types, and crops grown. Fields immediately surrounding the home are irrigated if there is a water source, and they are also sometimes referred to as *bustani*. Some crops (e.g. sweet potatoes, wheat, greens) are also grown on very small patches of land between fields along paths, usually on raised ridges (*matuta*, singular *tuta*). With ver few exceptions, farmers have both upland fields and irrigated gardens. In addition, a farmer's upland fields are rarely located in one place, but are scattered throughout the village.

Figure 14. The two basic categories of fields: upland, rainfed (14a) and valley bottom, irrigated (14b).

The main crop in Mhaji is maize (*Zea mays*), and the farming system is centered on this crop (Figure 15). Maize is grown both for food and as a cash crop. Some of the maize that is sold is simply the surplus of what has been planted for subsistence, but the majority of the maize sold for cash is cultivated specifically for sale. Many other crops are grown, both for food and cash (Table 1, page 30).

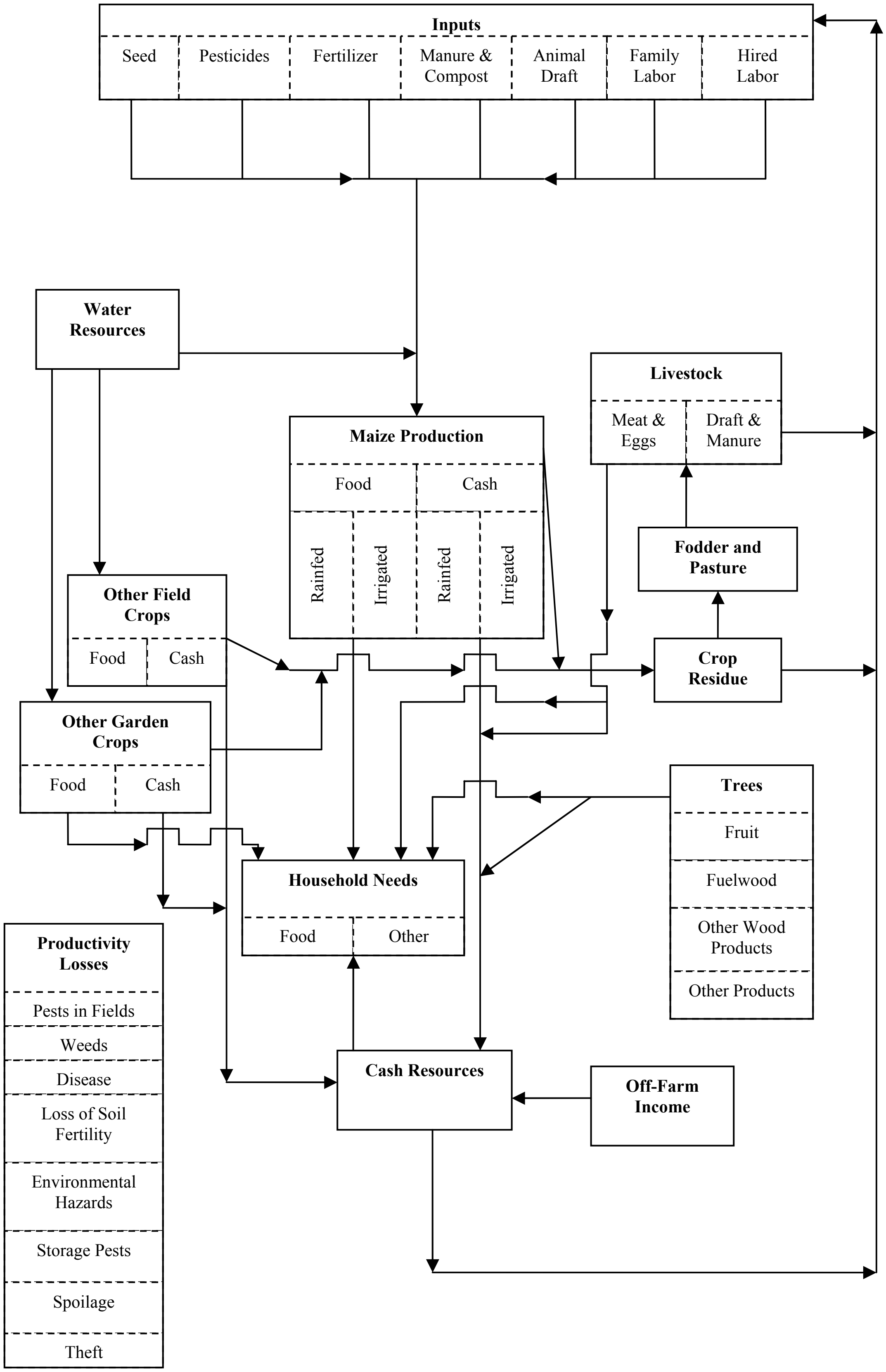

Figure 15. There are many components to the farming system in Mhaji, but maize cultivation is central.

Table 1. Common crops in Mhaji.

Crop	Food	Cash	Other	Field Types
Beans	Yes	Yes	NA	All
Cabbage	Little	Yes	NA	3, 4
Cassava	Yes	No	NA	2
Chinese Cabbage	Yes	Yes	NA	3, 4
Cowpeas	Little	Yes	NA	1, 3
Irish Potatoes	Little	Yes	NA	1, 3
Livingstone Potatoes	Yes	Little	NA	2, 4
Local Greens	Yes	Little	NA	3, 4
Maize	Yes	Yes	Beer	All
Millet	Yes	No	Beer	2
Mung Beans	Little	Yes	NA	4
Onions	Little	Yes	NA	3, 4
Passion Fruit	Yes	No	NA	3
Peas	Little	Yes	NA	1, 2
Pumpkins	Yes	No	Fodder, oil	All
Sunflowers	Yes (oil)	Little	NA	1, 2
Sweet Potatoes	Yes	No	NA	2
Tomatoes	Little	Yes	NA	3, 4
Wheat	Yes	Little	NA	1, 2

Key to Field Types
1 Rainfed, flat fields
2 Rainfed, sloped fields
3 Home gardens
4 Valley gardens

Very few farmers in Mhaji are concerned solely with subsistence production; for most, a cash income is an important component of the farming system. There is some mixed cropping of maize and beans in upland fields, but the majority of fields are monocropped. Valley bottom and home gardens usually exhibit complex mixtures of crops including maize, beans, greens, and other vegetables. The main exceptions to this pattern are market gardens of cabbage, tomatoes, and onions which are grown as a monocrop.

There is some manuring of fields and some composting of crop residue for use as fertilizer, but neither is widespread. Use of chemical fertilizers, most notably urea and calcium ammonium nitrate (CAN), is common. However, many times these fertilizers are under-utilized because farmers are unable to purchase enough. Burning of crop residue is the norm, particularly in maize fields, and this limits the amount of organic matter returned to the soil each year.

Weeds are a severe problem for most farmers. Common weeds include Bermuda grass (*Cynodon dactylon*), yellow nut grass (*Cyperus esculentus*), and bracken fern (*Pteridium aquilinum*). Weeding is performed two or three times, depending on the severity of the weed problem and availability of labor. Weeding is performed by hand using hoes, and it is quite laborious. Farmers are often unable to weed all of their fields adequately, and a field of stunted maize overrun with weeds in a common sight in Mhaji (Figure 16).

Pests and diseases are also serious problems. Maize stalk borers (*Busseola fusca*) are the most common pest and can produce significant losses. The most frequently used method of control for borers and other maize pests is the burning of crop residue prior to plowing of fields. Insecticides are used when they are available and when farmers can

Figure 16. Weeding is often late or inadequate.

afford to purchase them. It is not clear what types of insecticides are used, as villagers generally describe all pesticides as *dawa* (medicine) or DDT without distinguishing among different chemicals. There is also an insecticide derived from a local shrub, *utupa* (*Tephrosia vogelii*), which is used to some extent, but farmers prefer to use purchased insecticides as they require less labor to prepare and have more consistent potency. Various diseases are common. The most significant are bacterial blight (*Pseudomonas syringae*) among potatoes and vegetables, and Coffee Leaf Rust (*Hemileia vastatrix*) and Coffee Berry Disease (*Colletotrichum kahawae*). Copper sprays are used to control all of these diseases. Because the crops they attack are cash crops, farmers are willing to invest a significant amount in disease control, and copper sprays are much more common than insecticides.

Trees are common in the farming system in Mhaji. A large number of species are found on and around farms in Mhaji (Table 2). Introduced species are more common on the farm than indigenous species. The most common species are *Pinus patula*, *Acacia mearensii*, *Eucalyptus globulus*, *Citrus limon*, *Hakea saligna*, and *Prunus persica*. These species are commonly found on field boundaries, near houses, and in woodlots, and are

Table 2 Field observations of common trees in Mhaji.

Species	Common Name	Uses	Common Locations	Indigenous or Introduced
Acacia mearnsii	black wattle	fuelwood, charcoal, soil improvement	woodlots, boundaries	introduced
Agave sisalana	sisal	live fence, fiber poles	boundaries	introduced
Albizi gummifera	albizia	shade, soil improvement	fields, woodlands	indigenous
Annona cherimola	custard apple	fruit	fields, near homes	introduced
Arundinaria alpina	mountain bamboo	poles, handles, basketry	near homes, fields, woodlands	indigenous
Casurina equistifolia	horsetail tree	fuelwood, charcoal	boundaries	introduced
Citrus limon	lemon	fruit	fields, boundaries, near homes	introduced
Cupressus lusitanica	Mexican cypress	timber, fuelwood	boundaries	introduced
Erythrina abussinica	red-hot poker tree	shade, soil improvement	fields, woodlands	indigenous
Eucalyptus globulus	eucalyptus	timber, fuelwood	boundaries, woodlots	introduced
Euphorbia candelabrum	candelabra euphorbia	live fence	boundaries	indigenous
Euphorbia tirucalli	finger euphorbia	live fence, fish poison	boundaries	indigenous
*Ficus*spp.	fig	fruit, fuelwood, charcoal	water sources	indigenous
Grevillea robusta	grevillea	shade, fuelwood, timber	boundaries, fields	introduced
Hakea saligna	hakea	live fence, windbreak	boundaries, pathways	introduced
Jacaranda mimosifolia	jacaranda	shade, ornamental	pathways, near homes	introduced
Julbernardia globiflora	mukata	fuelwood, charcoal	woodlands	indigenous
Leucaena diversifolia	lucaena	fodder, soil improvement	fields, boundaries	introduced
Malus spp.	apple	fruit, fuelwood	fields, near homes	introduced
Musa spp.	banana	food, fodder, shade	fields, near homes	introduced
Oxytenanthera abussinica	lowland bamboo	alcohol, poles, handles, basketry	near homes, fields, woodlands	indigenous
Parinari curatellifolia	msaula	fruit, fuelwood, charcoal	woodlands, near homes	indigenous
Persea americana	avacado	fruit, timber, fuelwood	near homes	introduced
Pinus patula	Mexian weeping pine	timber, fuelwood	boundaries, woodlots	introduced
Prunus persica	peach	fruit	fields, near homes	introduced
Prunus salicina	plum	fruit	fields, near homes	introduced
Psidium guajava	guava	fruit, fuelwood	gardens	introduced
Ricinus communis	castor oil bush	medicine	near homes	introduced
Strychnos spp.	monkey orange	fruit, fuelwood	woodlands	indigenous
Syzygium cordatum	water berry	fruit, fuelwood, charcoal	gardens, water sources	indigenous
Uapaca kirkiana	mkusu	fruit, fuelwood, charcoal	woodlands	indigenous

occasionally found in fields. Indigenous species are commonly used for fruit (*Uapaca kirkiana*, *Parinari curatellifolia*, and *Syzygium cordatum*) and fuelwood (*Julbernardia globiflora*, *Uapaca kirkiana*, *Parinari curatellifolia*, and *Syzygium cordatum*) and are occasionally used for soil improvement (*Albizia gummifera* and *Erythrina abyssinica*). These species are rarely, if ever, planted, but are retained in fields, around homes, or near water sources; additionally, fruit and fuelwood are collected from nearby woodlands. Small, mixed thickets of indigenous trees and shrubs are also common, scattered throughout the landscape; these normally mark locations of spiritual significance in the indigenous belief system.

Farmers in Mhaji keep a variety of livestock with chickens being the most common. Chickens are provided shelter and some feed, usually kitchen scraps, but most of the time they range freely and forage for food. Pigs are the next most common animal kept in Mhaji. Without exception they are kept in small, elevated pens near the home and are fed kitchen scraps, crop residue, and maize bran. Goats are also common. They are kept penned for part of the day and herded by children on the edges of the village. Occasionally crop residue and green fodder are given to supplement grazing. Sheep are rare; when they are kept they are treated much like goats. Pigs, goats, and sheep are all raised for meat and for sale. Cattle are not common. When they are kept they are used primarily for draft power and are slaughtered only occasionally. Cattle are generally tended much like goats and sheep (Figure 17), but they are more likely to be given fodder to supplement grazing. Milk cattle are virtually non-existent (the first two milk cows in the village were purchased just before I left Mhaji in December 2000). A few farmers keep donkeys, using them to pull small carts. Donkeys are also kept penned part of the day and grazed part of the day. A number of types of small livestock, including rabbits, guinea pigs, and pigeons, are raised for meat and kept in home compounds.

Figure 17. Cattle in Mhaji are herded by small boys.

Land tenure in Tanzania rather confused (Bruce 1998). Traditional tenure among the Bena consists of usufruct rights with land allocated by local chiefs. Abandoned fields could be reallocated, but previous users could reclaim disputed fields, especially if they had used the land for an extended period or had abandoned the field recently (Lucas 1997). Since independence, the national government has claimed all land as public property, really an extension of British colonial policy, with village councils distributing land under the national government's authority. If the national government appropriates land, they are legally required to compensate the owner for improvements such as buildings or permanent crops (Shivji 1998). Villagization disrupted the land rights of many Tanzanians (Shivji 1998, Pitblado 1970), but had a limited impact on Mhaji (Sikauki 1999). The establishment of Tanwat and the Bena Wattle Scheme had a more significant effect in Mhaji with some land taken from villagers (Sikauki 1999, Mwasha 1999). There have been a number of attempts at national land reform since the beginning of economic liberalization, but this has done little to strengthen villagers' property rights

(Shivji 1998, Bruce 1994). However, in Mhaji most villagers do not realize that their property rights are tenuous, and they act as if they have firm ownership of their land. This is not to say there are no disputes over land ownership. The most common type of dispute is disagreement about the placement of field boundaries. Planting trees on a field strengthens a farmers claim on land, and boundaries are frequently marked with trees. This is often the first step when a farmer acquires a new field.

The majority of farm labor is family labor, but farmers will sometimes hire labor if they can afford it. The most common use of hired labor is for weeding. Farmers also frequently hire someone to plow fields with oxen. There are also three types of communal labor. *Ujamaa* is labor performed for the village council, such as maintenance of the main road or work in the village woodlot. *Umoja* labor is a group of farmers pooling their resources and working for each other on a rotating basis. For example, several farmers might work together to measure the spacing for their coffee plots. They would all work together on each farm, with the owner of the farm providing food and *ulanzi* for the day. *Migowe* labor is when a farmer needs to accomplish a large task quickly but can not hire any labor. He would ask his friends, relatives, and neighbors to help, provide them with *ulanzi* or other alcohol and perhaps food, and they would perform the work, with the understanding that he will return the favor when they need help.

This then is the environment in which the study was performed. The study site is moist and cool with heavy soils. One basic farming system exists in the area, but there are a number of variations on this agricultural theme. Maize production is central to the system, and maize is the most important crop for both food and cash. However, a wide variety of crops are grown in addition to maize, and the majority of farmers attempt to diversify their crops to some extent. Cultivation of at least one cash crop is the rule rather than the exception. Some cash crops are sold locally, while others are sold on regional and national markets. Food production is every farmer's primary goal, and production of cash is a secondary goal for most. Land is moderately scarce, but while there is a limited amount available for expansion of farms, the majority of farmers do not face a shortage of land. All farmers have access to a variety of field types, and most farmers' fields are scattered over a relatively wide area, providing a further level of diversification. Trees are common in the farming system. Livestock are present, but integration between crops and livestock is minimal. There is normally little danger of a food shortage, but production is far below its potential, and because of steadily declining soil fertility, the system is not sustainable. The addition of coffee to this system has the potential to raise both productivity and sustainability. The next chapter introduces coffee, its botany, history, and agronomy, and its potential to raise and sustain the productivity of the local farming system.

Chapter Three: Coffee

World History of Coffee

When the Prophet Mohammed was lying ill and prayed to Allah for relief, the angel Gabriel brought not only the Koran, but also coffee. The drink restored his health and gave him the strength to "unhorse" forty men and to "possess" forty women (Pendergrast 1999, Smith 1985). This is just one of the many myths surrounding the origins of coffee. While the real origins of coffee are more mundane, the history of coffee is quite colorful.

The genus *Coffea* comprises about ninety species (Willson 1999), but only a few are cultivated and just two, *C. arabica* and *C. canephora*, are commercially important. *Coffea canephora*, commonly known as robusta coffee, is a crop of warm lowlands, and therefore not considered here. *Coffea arabica* evolved in the forested highlands of southeastern Ethiopia (Willson 1999). Coffee has been used by the people of this area since time immemorial (Willson 1999), but its history of cultivation really begins around A. D. 850 when it was brought to the Arab colony of Harar (Smith 1985). From there coffee was sent to Mecca and spread throughout the Islamic world (Smith 1985). In this process, coffee reached Java (Willson 1999), and from there a stolen tree was taken to Amsterdam (Willson 1999). Gradually, coffee spread to the colonies of all the European powers. During this dispersion of coffee throughout the world, those who cultivated coffee tried to prevent others from gaining viable seeds; consequently, the history of coffee's spread is full of stories of daring thefts and can be quite entertaining (Willson 1999, Smith 1985, Wrigley 1988).

As coffee spread throughout the world, so did two diseases that played a significant role in its development as a crop: Coffee Leaf Rust and Coffee Berry Disease. Leaf rust was responsible for the end of coffee cultivation, and therefore the beginning of tea cultivation in Ceylon (Wrigley 1988), and the two diseases have played a role in the replacement of arabica coffee by robusta in many areas (van der Vossen 1985, Wrigley 1988). Despite much research into how to defeat these diseases, they have remained important to the present (Kimaryo 1999).

Like the spread of coffee as a crop, the history of coffee as a drink is often an entertaining story. Coffee has been blamed for a variety of health problems and social ills; conversely, it has also frequently been praised as a cure for many diseases. The stories concerning the rise (and in some cases the fall) of various establishments that buy and sell coffee are full of memorable characters and often devious business practices (Smith 1985, Wrigley 1988, Pendergrast 1999). However, there are really only two elements of this history that are germane to this study.

The first is the fact that, for the most part, the countries where coffee is consumed are not those where it is produced (Bates 1997, Wrigley 1988). Coffee is, then, primarily grown for export, and its trade is international. The second, related aspect of this history is the development of great volatility in the global price of coffee and the various failed attempts to control this volatility. Much of this volatility is the result of the weather in Brazil. Brazil is the largest producer of coffee, but large parts of its coffee growing regions are marginal and prone to frost and drought. A bad year in Brazil can cause dramatic price increases; similarly, a bumper crop in Brazil can cause the price to fall precipitously. Various valorization schemes, where governments purchase excess coffee, have been attempted to maintain higher price levels, but they have never worked for long. The International Coffee Organization, formed by an agreement among most producing countries and the major consuming countries, managed to maintain price levels for a time by imposing quotas on producing countries. But it has failed in the long run, and the global coffee market remains volatile (ICO 2001, Bates 1997, Pendergrast 1999, Wrigley 1988) (Figure 18).

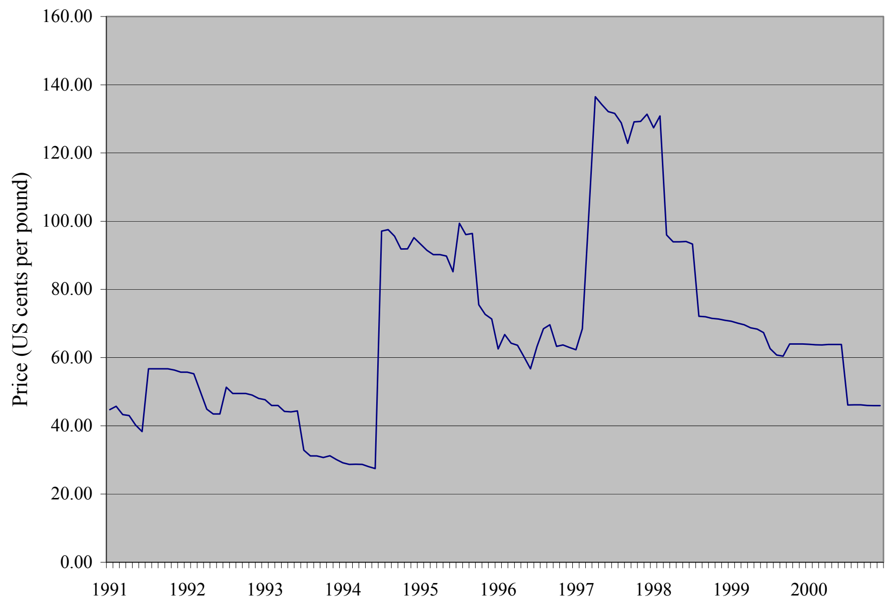

Figure 18. The global coffee market is volatile, causing large swings in prices paid to farmers in Tanzania.

Local History of Coffee

Robusta coffee was grown in the northwest of Tanzania in the region around Lake Victoria prior to European colonization, but arabica coffee first arrived in Tanzania in 1890. It was brought to the Kilimanjaro area by missionaries (Wrigley 1988). At first its cultivation was limited to colonial estates, but indigenous Tanzanians adopted it rather quickly (Kimaryo 1999). Kilimanjaro has very good climate and soils for production of high quality coffee, and the existing local farming system was suited to the integration of coffee (Fernandes, *et al* 1984). By the early twentieth century, coffee was an established component of the Chagga homegardens, and the Kilimanjaro Native Coffee Union had become a strong cooperative (Kimaryo 1999). Coffee cultivation spread rather quickly in northern Tanzania and to other regions with significant colonial settlement and suitable climate, most notably Mbeya and Mbinga regions (Figure 19) (Kimaryo 1999).

Coffee arrived in Njombe around the turn of the century, brought by Catholic missionaries. It became established as a crop mainly in the eastern and southern parts of the district. Coffee in Njombe has from the beginning been primarily a smallholder crop, and there were never any large estates. It was a popular crop until the arrival of tea in the 1940s and 1950s. The cool, wet climate of eastern and southern Njombe is not ideal for either coffee or tea: both grow more slowly in cold areas and are damaged easily by frost. However, tea grown in Njombe is often high quality, and the better prices this brings compensate somewhat for lower annual yields. In addition, tea is harvested and sold throughout the year, and many farmers preferred this more evenly spread income to coffee's single harvest. By the end of the 1950s, the coffee in most of Njombe had been abandoned and replaced with tea (Lwendo 2000).

Coffee did not reach Mhaji until the mid-1980s. Around this time the Ministry of Agriculture and the TCB promoted coffee as a cash crop to replace pyrethrum and black wattle, both of which were beginning to be abandoned due to collapsing markets. One farmer in Mhaji planted a small demonstration field (approximately one half acre) of coffee in cooperation with the district office of the Ministry of Agriculture. A handful of farmers (no more than ten) planted coffee at this time, as did the primary school. However, the crop did not become widespread, and farmers were rarely able to harvest

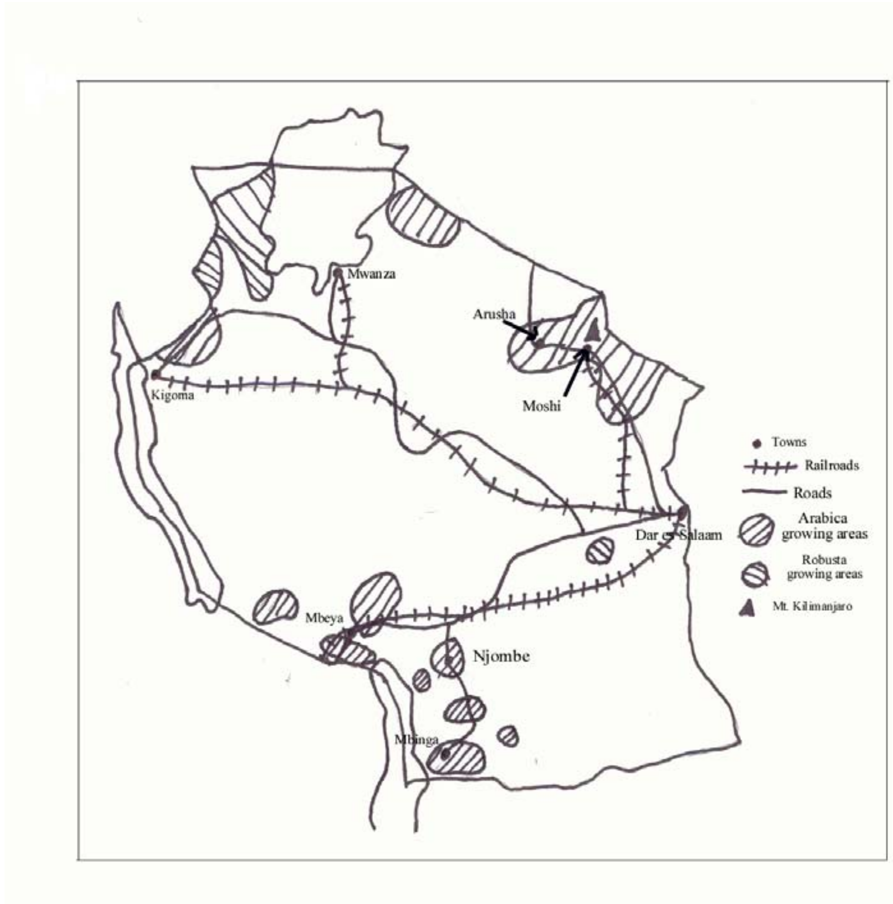

Figure 19. Coffee growing regions of Tanzania (Adapted from CMU 1997).

enough to sell. The primary school and a few individual farmers abandoned their coffee fields. Nevertheless, at least seven farmers in Mhaji and a few more in the neighboring villages of Igima and Lusisi continued to care for their coffee (Lwendo 2000, Sikauki 1999).

In the late 1990s, the government again began promoting coffee as a cash crop in Njombe (and throughout the Southern Highlands). This time, however, they seem to have met with more success in Mhaji and the neighboring villages. In late April 1999, ten farmers enlisted the aid of myself, the district coffee officer, the local agricultural agents, and a cooperative and marketing extension agent from the Irish Fund for Cooperative Development's Coffee Project for Njombe and Makete Districts in forming a cooperative and gaining some technical training in coffee cultivation. By December of 2000, this group (now the Mtitafu Coffee Growers' Association [MCGA]—Mtitafu is the name of the small river passing through Mhaji and the neighboring villages) had grown to 35 members, the majority from Mhaji, but several others from Igima and Lusisi. At that time, the group as a whole had only about four and one half acres of producing trees, but had planted approximately 30 additional acres. In addition, the primary schools of Mhaji and Igima were MCGA members with three to four acres of coffee each. The group had not only grown in size; it also seemed to have become a strong cooperative. The MCGA was chosen by the district coffee officer to serve as the core of the district's newest primary society, and had also been chosen to help instruct other new cooperatives in forming and running a cooperative.

Botany and Requirements

Coffee is a small tree that, left to itself, will grow to about 45 feet. The normal form is a single orthotropic main stem with branches in opposite pairs. These primary branches bear most of the leaves and fruit. The leaves are evergreen, glabrous, and shiny, and grow in opposite pairs. There are six buds in each leaf axil. Given good conditions for flowering, four of these buds will normally produce inflorescences. If the primary branch is cut back, a pair of secondary branches will sprout from the first pair of buds and flowers will form below them; occasionally this will occur spontaneously. Coffee flowers are small, white, and aromatic, and they are born in clusters of up to twenty. The fruit is a drupe, red when ripe, normally containing two seeds, each flat on one side and convex on the other. Sometimes only one seed develops, resulting in an ovoid "peaberry" (Wrigley 1988, Willson 1999).

The root system of coffee consists of a short taproot and numerous lateral roots. Some of the lateral roots bend downward and reach depths of up to three meters. The remaining lateral roots form a dense mat of feeder roots which extend about two meters deep and two meters laterally from the stem. Roots will not extend below the water table, and they have trouble penetrating hard pans, dense clay layers, and gravel layers (Willson 1999, Wrigley 1988).

Young leaves are pale green becoming dark and shiny as they mature. Coffee is evergreen with the leaves remaining on the tree for nine to ten months (Wrigley 1988), and leaves remain active throughout the dry season. Coffee leaves are sensitive to direct sunlight and both high and low temperatures. Shaded leaves are much more photosynthetically efficient than unshaded leaves. In addition to this, full sunlight can raise the temperature of leaves as much as 20°C above the optimum and can damage them directly (Willson 1999, Cannell 1985, Wrigley 1988). Temperatures between 15 and 24°C are acceptable, with 20°C the ideal temperature. Above 25°C photosynthetic activity is reduced, and above 30°C it stops entirely. Extended periods above 30°C can permanently damage leaves. Short periods of low temperatures are insignificant, but frost damages leaves and can kill the tree (Wrigley 1988, Willson 1999).

Flower buds develop for several months, then growth stops and flowers become dormant. Dormancy is gradually reduced as the buds experience a period of water stress. After several weeks of water stress, dormancy is broken, and removal of the water stress reinitiates flower development. When this happens, the buds develop quickly, and the flowers bloom within a few days; it is common for large numbers of trees to bloom "gregariously" within a few days of each other, even if flower development was initiated at different times. Flowers bloom for two to three days. *Coffea arabica* is self-fertile and even isolated trees can produce fruit. Under good conditions, a coffee tree is able to set more fruit than it is able to support photosynthetically. Some fruit drop occurs, but even without ideal conditions, overbearing can occur. In severe cases this can result in die-back of the tree which often reduces the number of flowers and fruit produced the following year. If not controlled, this process, known as biennial bearing, can stress the tree and eventually reduce its life span (Willson 1999, Wrigley 1988).

While coffee is grown in various areas throughout the tropics, there is a relatively narrow range of environmental conditions under which it will flourish. With few exceptions, most notably the Paraná region of Brazil, coffee is limited to tropical highland areas (Wrigley 1988) which have climates similar to that of the Ethiopian highlands where coffee originated. The most important factors determining the suitability of an area for coffee cultivation are temperature, moisture, light intensity, and wind (Wrigley1988). While certain cultural practices can compensate for unfavorable environmental conditions by altering the environment of the coffee field, there are limits to what these practices can do. Furthermore some of the more effective practices, such as irrigation, are too expensive to be practical for most small-holder farmers, including those in Mhaji.

The distribution of precipitation throughout the year is as important as total annual rainfall in coffee cultivation (Willson 1999). Changes in water availability are important in the initiation of flower development and in controlling flower dormancy, as well as in inducing vegetative growth (Willson 1999). Therefore, there must be some period of water stress during the year for coffee trees to develop properly; however, because coffee is evergreen and has no mechanism for limiting moisture loss during dry periods, these periods must not be too long. It has been calculated that under ideal conditions coffee needs at least 1,100 millimeters of rain per year if it is not irrigated (Achtnich 1958 in Willson 1985c). Because of imperfect rainfall distribution, variations in soils, and other factors such as wind, in most cases 1,200 to 1,500 millimeters of precipitation are needed each year (Wrigley 1988). The dry season should not exceed more than four months unless frequent cool and cloudy weather reduces transpiration or the trees can be irrigated (Willson 1999).

Willson (1999) describes an ideal coffee soil as deep, more than three meters, open textured to promote good drainage and root growth, having a high water capacity and high levels of organic matter, and slightly acid, with pH between 5.2 and 6.3. A coffee tree's ability to survive the dry season is largely dependent on soil conditions. Soils must have a high water retention capacity and be deep enough to allow the tree's roots to explore a large enough volume. In Kenya coffee roots were found to reach depths of three meters (Willson 1999). Shallow soils not only provide inadequate reservoirs of moisture during the dry season; they can also be prone to waterlogging during heavy rains, and this damages coffee roots (Willson 1999). Hardpans, heavy clay layers, and other features that inhibit drainage or root penetration are significant problems for coffee (Wrigley 1988).

Coffee is sensitive to temperature. Average annual temperatures between 15°C and 25°C can support coffee growth with 20°C the ideal (Willson 1999, Wrigley 1988).

Coffee trees can survive temperatures outside this range, but even short periods of high or low temperatures can reduce production (Wrigley 1988). Above 25°C no photosynthesis occurs in coffee leaves, and if temperatures are above 30°C for an extended period the leaves will be damaged (Willson 1999). Long periods of cold can damage coffee trees, and frost can kill them (Willson 1999). The amount of variation in temperatures throughout the day and the year is as important as the average temperatures (Wrigley 1988). Diurnal variations are particularly important as wide fluctuations between daily high and low temperatures can lead to Mt. Elgon disease. The maximum diurnal variation tolerated by *C. arabica* is 19°C (Wrigley 1988).

Other environmental considerations can be important, often because they can accentuate or mitigate the effects of temperature and moisture (Willson 1999, Wrigley 1988). Altitude affects temperature, with temperature decreasing with higher altitude. In equatorial regions, the proper temperature for coffee cultivation is normally between 1,000 and 2,000 meters above sea level. Clouds and humidity can be important in making coffee cultivation possible in marginal areas. High humidity reduces the rate of evapotranspiration, and therefore the amount of precipitation needed. Cloud cover can raise humidity and affect temperature, most importantly by mitigating diurnal temperature variation. Mist can also be important in marginal areas by reducing transpiration and supplementing precipitation. This can be particularly important during a long dry season. However, high humidity and mists can provide an environment good for a number of diseases. Strong or constant winds can physically damage coffee trees, but in general the most important effect of wind is increased evapotranspiration (Willson 1999, Wrigley 1988).

Coffee Cultivation

It is likely that there are nearly as many methods of coffee cultivation as there are places where it is grown. These range from barely managed “wild” trees in the region of coffee’s origin to large, intensively managed estates in areas where coffee might not survive on its own (Wrigley 1988). The most commonly manipulated variables in coffee culture are the spacing of trees, the amount of shade, the pruning system, the inclusion of other crops in the system, and the level of inputs such as fertilizers and pesticides (Wrigley 1988, Willson 1999). I will discuss the cultural practices most common in Mhaji and other parts of Njombe.

The most common source of planting stock in Njombe is the District Agriculture and Livestock Office. This office sells coffee seed produced in seed orchards that have been certified by the Tanzania Coffee Board as producing superior seed. On occasion a farmer may use locally produced seed in an effort to save money; however, the government seed generally has better germination rates and produces superior seedlings, and cultivars known to produce well in the local environment are readily available.

Seed is generally germinated in a mulched and shaded seedbed near the home or in an irrigated garden and then transferred to containers; bare root seedlings are rare in Njombe. These containers are usually polythene tubes, but other containers, such as used cans, bamboo joints, and used plastic bags, are used when these are not available. Farmers in Mhaji sometimes purchase tubes, but they are more likely to recycle tubes used in Tanwat’s tea operation. Ideal containers are at least four inches in diameter and at least six inches deep; smaller containers will work, but can inhibit root development and may result it nutrient deficiencies in older seedlings (Coffee Management Unit

1997). In Mhaji farmers who use tubes from Tanwat's tea operation have access to tubes of adequate size, but those who purchase them are normally unable to afford large enough tubes and must make do with smaller sizes. Containers should be filled with a mixture of rich soil and well-rotted manure or compost (Coffee Management Unit 1997). The exact proportions of soil and manure depend on the quality of soil (Wrigley 1988, Willson 1999); in Mhaji the mixture ranges from equal parts soil and manure to three parts soil to one part manure. The availability of manure can affect the proportions used as much as the fertility of the soil used, and in some cases no manure is used. Seedlings are placed in the containers when the two cotyledon leaves are fully developed, approximately two weeks after germination in Mhaji.

Containerized seedlings are tended in nurseries located near a source of water, either at the home or in a valley garden (Figure 20). Seedlings are cared for in the nursery throughout the dry season and must be irrigated. Weeds can be a problem in some cases, primarily because weeding of nurseries is tedious work. Seedlings in the nursery are susceptible to damping off, a fungal disease caused by *Rhizoctonia solani*, and cut worms (*Agrotis* spp.), but farmers are rarely able to afford fungicides or insecticides for the nursery. Fertilizer application can improve the quality of seedlings, but this is also usually too expensive for farmers. These inputs are only used by the richest farmers and those producing seedlings for sale. Nurseries are kept under moderate shade; low shade over each nursery bed is most common, but higher shade over the entire nursery also occurs. In some cases trees or bananas are used rather than artificial shade. When artificial shade is used, the shade is gradually reduced during the three to six weeks prior to out-planting in order to "harden" the seedlings and minimize the shock of transplanting. During this period of hardening, irrigation is gradually reduced as well. Ideally seedlings are planted in the field when they are eight to twelve inches tall and have about ten pairs of leaves (Coffee Management Unit 1997). In practice seeds are planted in the nursery sometime between December and March, and seedlings are cared for in the nursery for eight to twelve months and planted in the field at the beginning of the rains, regardless of the their size.

All the coffee in Mhaji is planted in existing fields. In most cases this means that there is no chance to make use of existing shade trees, nor is there any need to remove trees. Ideally, shade trees would be planted at least one year prior to the coffee itself to ensure that they are established and providing some shade as early as possible (Douglas and de J Hart 1984). At the same time, the field should be planted with some leguminous cover crop which will be plowed under (Wrigley 1988, Willson 1999). In practice, neither of these practices are likely to occur in Mhaji, primarily because farmers are not willing to postpone the first coffee harvest.

Figure 20. A coffee nursery.

Field preparation consists of five steps. First, the spacing of the trees is measured and a stake is placed at each planting site. The spacing used almost universally in

Tanzania is 2.7 meters between trees and 2.7 meters between rows (1,330 trees per acre). The second step is digging the holes in which the coffee will be planted. The ideal size for these holes is two feet in diameter and two feet deep (Figure 21a). When the holes are dug, the topsoil is preserved separate from the subsoil. During the third phase of field preparation, the holes are left open for four to six weeks. Approximately one month prior to planting, the holes are filled with a mixture of topsoil and at least one *debe* (twenty liters) of well-rotted manure; if possible, 100 grams of triple super phosphate fertilizer is also added. The stakes are then replaced to mark the location of each hole. Finally, once the rains have started in earnest, the coffee trees are planted along with the shade trees. The young trees are covered by temporary shade which is removed gradually, minimizing the shock to the trees (Figure 21b) (Coffee Management Unit 1997).

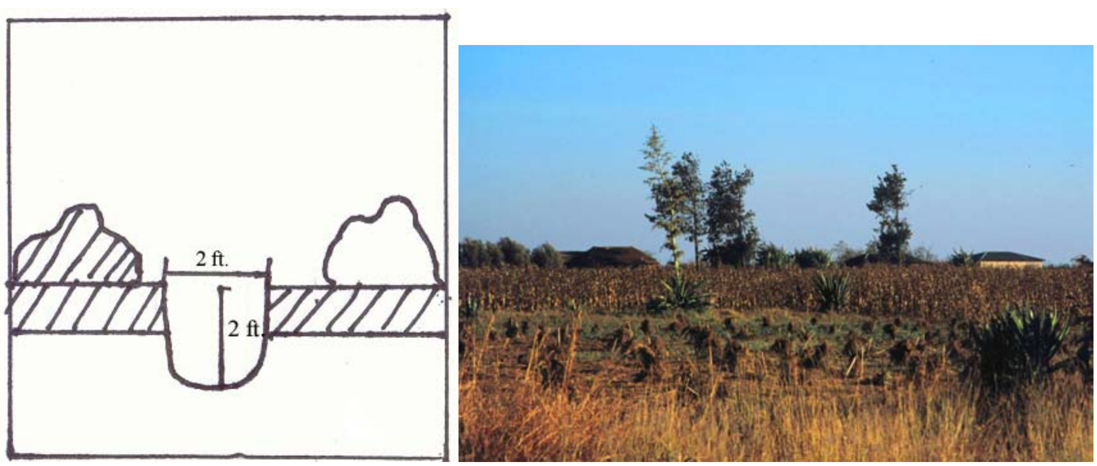

Figure 21. A. A hole for planting coffee (Adapted from Coffee Management Unit 1997). B. Coffee seedlings with temporary shade.

In Mhaji as in most of Tanzania, a single-stem pruning system is used. Pruning serves several purposes. The main stem is "capped", or cut back, three times at heights of approximately 50, 110, and 170 centimeters to promote branching and increase the number of fruit-bearing shoots (Figure 22). This primary pruning occurs just before the beginning of the rainy season. Secondary pruning occurs throughout the year. This pruning is intended to remove older, non-bearing wood and to open up the trees. This serves to increase the tree's yield by increasing the proportion of fruit-bearing shoots and by allowing light to reach the entire tree. By increasing the amount of light reaching the interior of the tree and allowing better circulation of air among the leaves, pruning also creates a less hospitable environment for many insect pests and diseases, most importantly Coffee Berry Disease and leaf rust. Finally, pruning makes tasks such as picking the fruit and applying sprays easier (Coffee Management Unit 1997).

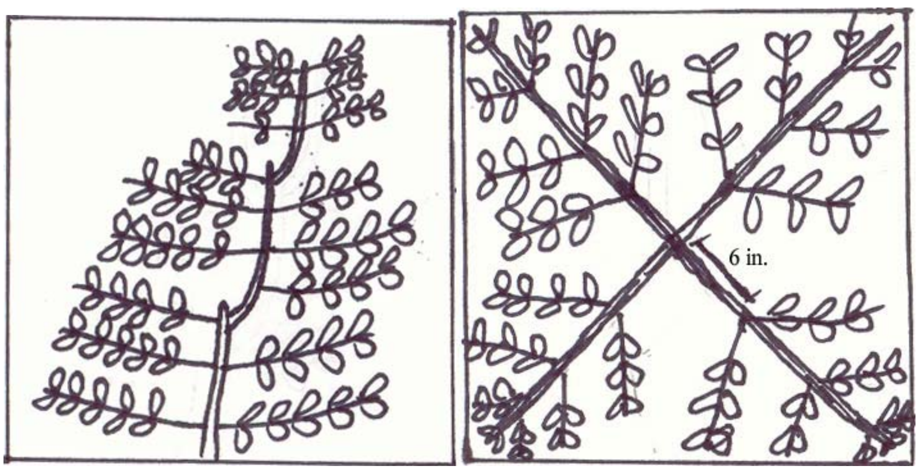

Figure 22. Diagrams showing how coffee should be pruned, side view (left) and top view (right) (Adapted from Coffee Management Unit 1997).

The amounts of nutrients removed with the coffee crop are not large when compared with many crops (Willson 1985a), but they are significant. In Mhaji, the material removed in pruning is left in the field, and no nutrients are lost in this manner. However, the pulp is rarely returned to the field, and the parchment is never returned, so the nutrients and organic matter in these parts of the fruit are lost, even though they are not part of the end product. Willson (1985a) reports that the bean, pulp, and parchment in one metric ton of green beans are equivalent to roughly 60 to 65 kilograms N, 10 to 15 kilograms P_2O_5, and 55 to 60 kilograms K_2O (135). This removal of nutrients and organic matter year after year necessitates the application of fertilizers to maintain good production. In Tanzania it is recommended that farmers apply one *debe* of manure or composted crop residue and 500 to 700 grams of NPK fertilizer around each tree each year (Coffee Management Unit 1997); in practice, most farmers are able to apply the manure or compost at the recommended level, but few are able to afford the other fertilizer. If farmers can afford to purchase fertilizer, they will apply it to maize fields first, and only the most prosperous can afford enough to apply it to their coffee as well. Manure and compost are carried to the field by headload and applied by hand around the edge of each tree's canopy, as this roughly coincides with the location of the majority of the tree's feeder roots (Coffee Management Unit 1997).

While in some regions of the world coffee is grown without shade trees, this is rare in East Africa. Coffee evolved as an understory tree in rather dense forest (Willson 1999, Wrigley 1988). Consequently, coffee was traditionally grown under the shade of trees retained during the clearing of forest, but more recently it was found that unshaded trees produced greater yields, probably because more flowers are initiated in full sun and because of the reduced competition for water between coffee and shade trees (Wrigley 1988). Further study has found that unshaded coffee responds better to fertilizer application than shaded coffee, often dramatically (Willson 1999). However, the higher yields necessitate greater inputs of fertilizer (Wrigley 1988) and may shorten the life span of the trees. The stress placed on the trees by growing in full sunlight may contribute to this shortened life span (Kimaryo 1999), resulting in higher costs in both the short and long terms. Therefore, while unshaded coffee is common in large estates, small holders are rarely able to afford the inputs (Willson 1999).

The presence of shade trees affects the microenvironment of the coffee field and can provide a variety of benefits. By reducing the amount of sunlight reaching the soil shade trees can inhibit weed growth. Shade trees can also help to minimize diurnal temperature variations, an important consideration at high elevations and latitudes. This effect is the result of both lower daytime temperature and higher nighttime temperatures; thus, shade can reduce evapotranspiration during the day and reduce the risk of frost at night. Wind velocity can be reduced within the field, especially if shade trees are combined with windbreaks. Leaf litter from shade trees can act as a light mulch, inhibiting weed growth and helping to preserve soil moisture (Willson 1999, Wrigley 1988). Shade trees can also be important in soil maintenance. Decomposing leaf litter replaces organic matter and, to a lesser extent, replaces nutrients removed with the coffee crop. Deep-rooted species can access nutrients that have leached below the reach of coffee roots, returning them to the surface through leaf litter. Leguminous species can also fix nitrogen (Wrigley 1988, Beer 1988).

While shade can encourage some insect pests and act as a source of Armillaria infection, the microenvironment created by shade can inhibit the establishment and spread of many pests and diseases (Willson 1999, Douglas and de J Hart 1984). Coffee Leaf Rust is the most important pathogen affected in this way (Wrigley 1988).

A number of species are used as shade trees. In Mhaji and the surrounding area *Grevillea robusta* and *Albizia gummifera* are commonly used as overstory species, shading the entire field. These are often supplemented with shorter species such as *Leucaena diversifolia*, *Prunus persica*, *P. salicina*, *Citrus* species, and other fruits, particularly when the larger, slower-growing trees are too young and small to provide adequate shade (Figure 23).

Figure 23. An established coffee field with little shade.

Weeds can be a significant problem in the early years of a coffee field's establishment (Wrigley 1988). Seedlings are particularly sensitive to competition from weeds. Because coffee trees' feeder roots are rather shallow and sensitive, weeding itself can be a problem if it is not performed carefully (Coffee Management Unit 1997). Once a field has matured, however, the soil between trees is heavily shaded, and weeds become less problematic (Willson 1985b).

In Tanzania, animal pests are rarely a problem. A number of insects, nematodes, and even birds and mammals may affect small areas, but nationally they are not considered economically important (Kimaryo 1999). During my time in Mhaji, the only pests reported were cutworms affecting a few nurseries and an unidentified stem-boring insect which damaged a single mature tree.

In contrast to animal pests, diseases are an important factor in coffee production in Tanzania (Kimaryo 1999). Two fungal diseases in particular, Coffee Berry Disease

(*Colletotrichum kahawae*) and Coffee Leaf Rust (*Hemileia vastatrix*), can be devastating to large areas. Leaf Rust (CLR) appears as rust colored, powdery spots on mature leaves and causes them to drop prematurely. This reduces the yield in the following year, and can eventually lead to the death of the tree. Coffee Berry Disease (CBD) is unlikely to kill a tree; however, it affects ripening fruit, causing it to rot and severely reducing yields. Both of these diseases are very contagious and virulent and can infect entire fields. They can be prevented with fungicides, typically copper sprays, but cannot be cured once a tree is affected (Lwendo 1999, Willson 1999, Wrigley 1988). Both of these diseases are present in Njombe, and the preventative sprays are one of the largest expenses for coffee farmers in Mhaji. Other, less important diseases that are present in Mhaji are bacterial blight (*Pseudomonas syringae*), also controlled by copper sprays; Elgon dieback, an infection of leaf nodes by *C. kahawae* that is facilitated by large diurnal temperature fluctuations; and Armillaria root rot (*Armillaria mellea*), which usually spreads to coffee from the roots of other trees (Lwendo 1999, Wrigley 1988).

Coffee is harvested from June to September in Mhaji. The exact time of harvest depends on when the previous rainy season began and when a particular field received enough rainfall to initiate flower blooming. Harvesting is a task that must be done carefully. Not all the fruit will ripen at the same time, and picking fruit that is not yet ripe or that is overripe will lower the quality of the crop at sale. Furthermore, the buds that will form the flowers which will become the next crop are present during harvest and can be damaged by careless harvesting, reducing the next year's yield (Lwendo 1999). The seeds must be removed from the fruit as soon as possible after harvesting or quality will be affected. A delay of even one day between harvesting and processing of the fruit can have a significant effect on crop quality (Kimaryo 1999). Processing consists of removing the seeds from the fruit, known as pulping; soaking the seeds in water to remove the mucilage that clings to the parchment, known as fermenting; and drying the resulting "parchment" coffee. In Mhaji, pulping is normally performed with a hand-cranked pulper (Figure 24). Fermenting is done is plastic buckets. Drying is performed by spreading the wet coffee on burlap sacking, reed mats, or woven bamboo screens and drying it in the sun. The drying coffee is covered or moved inside at night and during wet weather. The drying process continues until the moisture content is between 10 and 12 percent. This normally takes approximately two weeks, but the length of drying can vary widely depending on the weather (Coffee Management Unit 1997).

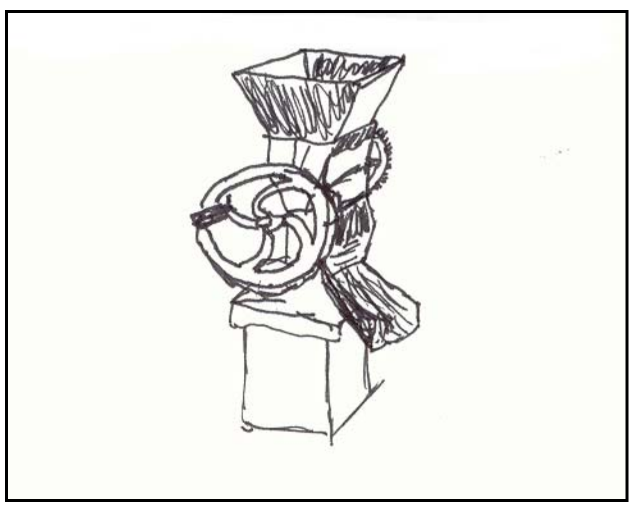

Figure 24. A hand-cranked coffee pulper of the type used in Mhaji.

Coffee Markets

There is a significant difference in how coffee and other cash crops grown in Mhaji are marketed. Tomatoes, peaches, and other fruits and vegetables are sold primarily in Njombe town and Makambako; a farmer usually sells them himself, although he may utilize a middleman. Grains, legumes, and potatoes also may be sold on the regional market, but they are often sold nationally; this is particularly true of maize and potatoes. These crops are frequently sold through a middleman, largely because of the cost of transporting them to Dar es Salaam or another market center. In the case of maize, these brokers sometimes purchase the crop before it has been harvested. All of these crops are sometimes sold in small amounts in Mhaji itself. Some crops such as local greens, sweet potatoes, and Livingstone potatoes are sold almost exclusively on this local market.

In contrast to other crops, coffee is sold exclusively on the world market. There is very little coffee consumed in Tanzania, and those companies that produce coffee for the domestic market must purchase it as if they were exporters (Kimaryo 1999). All of the coffee grown in Tanzania is sold at auction through the Tanzania Coffee Board (TCB). Farmers do not sell their coffee directly to exporters; rather they sell it to the TCB.

Farmers who do not produce enough coffee to sell it individually are organized into Primary Societies; there are four primary societies in Njombe. In many cases these primary societies are made up of smaller cooperatives, and this is true for all of Njombe's societies. The Mhaji Primary Society comprises three cooperatives, including the Mtitafu Coffee Growers' Association.

Coffee's Place in the local system and its potential

Beets (1990) says of upland cereal-based farming systems that "productivity is only a small fraction of what it could be", that they are rarely stable, and that "most are in transition" (383, 387). Both Beets and Raintree (1986) describe the possibility of raising productivity and sustainability by shifting toward more intensively managed agroforestry and mixed farming systems. Coffee has the potential to be part of a highly productive farming system of this type.

The Chagga home gardens in the Kilimanjaro area are probably the best example of this (Fernandes, *et al* 1984). These home gardens are small, intensively managed fields in which a large variety of herbaceous and woody crops are integrated. The crops include a number of food crops; cash crops such as coffee, cardamom, bananas, and timber; and other crops such as fodder for livestock, organic pesticides and medicines, and fuelwood. The space within the small fields is used very efficiently by taking advantage of the different heights of various crops (Figure 25). Livestock are closely integrated; they are kept penned and fed fodder cut from the home garden, and their manure is returned to the field. The system has proven to be highly sustainable, and fields that have been used for a century are still productive (Fernandes, *et al* 1984, Mwasha 1999).

The slopes of Mt. Kilimanjaro are, of course, a unique environment, and it is impractical to expect that this system might be replicated in Mhaji. However, the Chagga homegardens do provide an example of how coffee can be a part of a productive and sustainable system. Given this example, it is possible to describe an idealized coffee-based system for Mhaji (Figure 26, page 61).

Figure 25. Chagga home gardens include coffee as part of a multi-story agroforestry system (Adapted from Fernandes, *et al* 1984).

This ideal farm would include between one and two acres of coffee, as this is the amount of coffee one farmer can care for without hiring labor (Lwendo 2000), and because there is no pool of skilled coffee laborers in Mhaji. The remainder of the farm would look much like the average farm in Mhaji. Enough area should remain available for producing maize that food security is not endangered, and for many farmers, enough should remain to allow some production of maize for cash. Other crops would continue to be grown, particularly near the home and in the valley gardens. Trees need not be isolated to the coffee field and should continue to be planted in other fields, along boundaries and pathways, and, if appropriate, in separate woodlots. Coffee should not take the place of maize as the center of the farming system. Instead, coffee should be one component of a more balanced system.

The coffee field itself should be located as near to the home as possible; this will allow tasks that must be performed over many days, such as harvesting and pruning, to be done more easily. The field should be somewhat heavily shaded; this will reduce

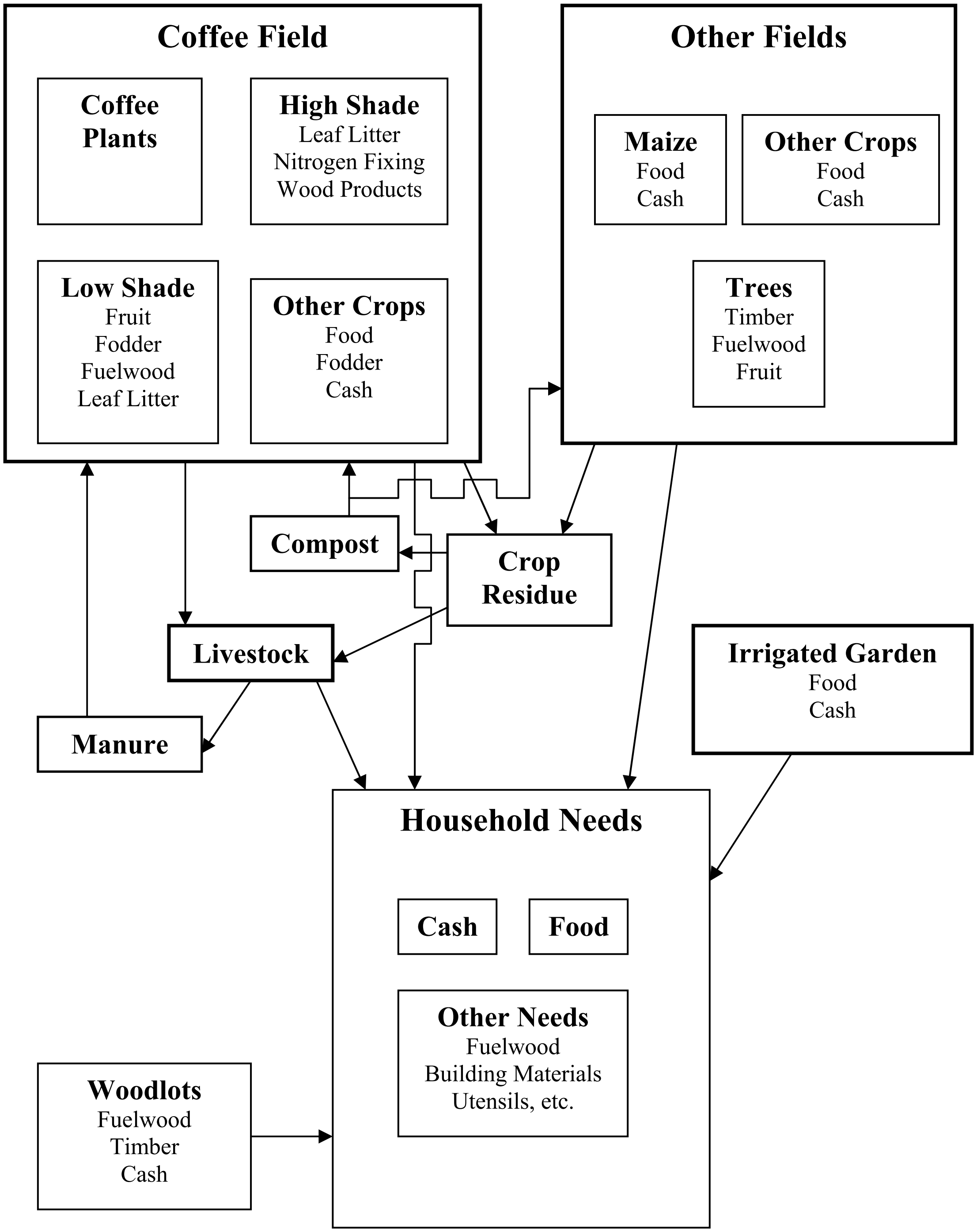

Figure 26. Idealized coffee-based farming system.

transpiration during the long dry season and help to minimize diurnal temperature variations, the two environmental factors that are most likely to be problematic in Mhaji. *Albizia gummifera* is the best tree for tall shade in Mhaji; it is native to the area, and seeds can be obtained easily and cheaply; it is fast-growing; it has a good form for shading large areas; and it is nitrogen fixing and produces a large amount of leaf litter, which aids in maintaining soil fertility. Below this overstory, a combination of fruit trees, bananas, and small leguminous species such as *Leucaena diversifolia* should be established. Inclusion of *Tephrosia vogelli* would allow production of organic pesticide as well as providing nitrogen fixation. This combination will allow for some food and cash, fuelwood, and high quality fodder to be produced. In most cases a windbreak should be planted given the strong winds prevalent in Mhaji.

Below this would be the coffee, planted at the standard 2.7 meters by 2.7 meters spacing. This relatively wide spacing allows other crops to be planted below the coffee. In Mhaji, two crops of beans can be planted each year; small amounts of grains for home consumption or beer production could also be grown, as well as small amounts of root crops or vegetables. In some parts of Njombe, pineapples are grown with coffee, and this can be particularly valuable as an erosion control device on sloped fields. Crop residue should be left as a mulch or composted and returned to the field as fertilizer.

Livestock should also be an integral part of coffee farming. One or two milk cows are ideal, but goats, sheep, pigs, and even small livestock such as rabbits or guinea pigs can be valuable. Livestock should be kept penned as much as possible to maximize the amount of manure that can be collected and returned to the field; this will also increase the efficiency with which feed is converted to meat and milk. Fodder grasses, woody fodder species, and crop residue can be produced on the coffee plot and carried to the livestock.

To be an ideal farming system, this proposed farm must not be limited to meeting the goals of development workers or the national government. The description in Chapter Two of the existing farming system showed that the two main goals of nearly all the farmers in Mhaji are the production of food at levels which ensure household food security and the production of some cash income. The proposed coffee-based system is compatible with both of these goals. The combination of food crops integrated in the coffee field and crops grown in other fields will allow the maintenance of subsistence production. Coffee is, of course, a cash crop, and it can replace or supplement maize and other cash crops. Furthermore, because coffee can be combined with a large number of other crops, including coffee would allow farmers to maintain a high level of crop diversity.

It is not possible, of course, for a farmer to adopt such a system immediately. The cost in cash and labor would simply be too much. However, given the potential to improve the system through the addition of coffee, many farmers in Mhaji have considered adding coffee to their household farming system. Some have decided to grow coffee, and others have decided not to. Because converting from maize-based farming to mixed farming or agroforestry holds so much potential to raise and sustain productivity, it is worthwhile to try to understand how and why farmers decide whether or not to grow coffee. The next chapter presents a theoretical foundation for beginning the attempt to understand farmers' agricultural decision-making process.

Chapter Four: Risk and Decision Making

Defining Risk

Any discussion of risk and uncertainty must begin with a discussion of the terms' definitions. Because "risk" and "uncertainty" are not exclusively technical terms, there is the danger that their use as such might cause confusion. Indeed, when the two words are used by economists and anthropologists, they are not always assigned precisely the same definitions. In addition, because these professional definitions are more precise than the common dictionary definitions, it can be difficult to know exactly what is meant by "risk" and "uncertainty".

Social scientists have applied a number of definitions to these terms. While all these definitions tend to imply the non–technical meanings of the words, that is, uncertainty meaning a lack of complete information, and risk connoting an exposure to danger due to uncertainty, they are generally more specific, and they vary somewhat. These variations lead to some debate among social scientists, particularly between economists and anthropologists, as to what the best definitions are. The most basic of these debates is whether in practice there is any difference between risk and uncertainty and the ways in which people react to them.

The seminal work concerning this question is Knight's *Risk, Uncertainty, and Profit* (1971). As the title implies, this book is concerned with risk and uncertainty in markets and how they can affect one's ability to make profits. While this is not directly relevant to how smallholder farmers make decisions, much of the work that has been done in this area uses definitions based on Knight's. Knight drew a firm distinction between risk and uncertainty. Both concern imperfect knowledge of the future; however, risk is measurable and uncertainty is not. Risk, then, concerns situations in which knowledge of the future is incomplete, but enough is known that a reasonable guess can be made based on known probabilities. An example of this is predicting rainfall: A farmer can not know for certain how much rain will fall in the coming year, but he can predict the probability that a certain level of rainfall will occur based on the experience of previous years. In contrast, uncertainty is either a complete lack of knowledge or knowledge so imperfect that no reasonable guess can be made, and any prediction would be based entirely on blind chance. For example, a farmer presented with a crop completely new to his region has no store of knowledge on which to base a prediction of how the crop might perform.

The other side of this debate is the idea that this distinction between uncertainty and risk is really meaningless. In this view of risk and uncertainty, the difference between the two is recognized, but it is assumed that when people are faced with uncertainty and must make decisions without knowing the odds of possible outcomes, they guess based on what knowledge they do have (Cashdan 1990). In other words, if a farmer is does not have the knowledge necessary to make a decision, he will substitute other knowledge (Cancian 1980). In our example of the farmer presented with a new crop, the farmer might replace the uncertainty concerning the crop with the risk of trusting the advice of an extension agent. The farmer makes a prediction of the accuracy of the extension agent's prediction, based on his knowledge of the extension agent (Amacher and Hyde 1993). This prediction about a prediction is likely to be less accurate than if the farmer were able to make his prediction more directly based on knowledge of the new crop, but it does not involve blind chance. The heart of this argument is that true uncertainty, a complete lack of knowledge concerning a decision, rarely if ever occurs; thus, uncertainty simply increases risk.

In this study, I will adopt a definition of risk and uncertainty based on this second argument. While it is conceivable that a farmer might have to make a decision in the face of a complete lack of knowledge, it does not seem likely to happen in the present case. Coffee is not entirely new to Mhaji. A few people in the village have grown coffee for a period of time sufficient to have some knowledge of its performance. Others have relatives in other areas where coffee is more prevalent, or may have migrated to Mhaji from such areas themselves. Foster and Rosenzweig (1995) have demonstrated the importance of such "spill over" knowledge, learning by watching friends and neighbors, in the spread of new crops and technologies. In addition to this first- and second-hand knowledge of coffee, government extension agents have been active in the area for some time, and most, if not all, villagers have knowledge of their expertise, and they are generally well respected. Amacher and Hyde (1993) report that extension agents are often the most important influence in helping farmers to adopt new technologies. In short, while the farmers in Mhaji may have very limited knowledge of coffee as a crop, their knowledge is not so incomplete as to force them to make decisions concerning coffee based on blind chance alone. Consequently, in this paper I will treat risk and uncertainty as essentially the same thing: the danger farmers are exposed to due to their imperfect knowledge of the future.

Risk and Decision Making

The aspect of risk we are concerned with is its effect on farmers' decisions about crop selection. This can be put simply with two questions. First, are farmers risk averse or are they risk takers? Second, what actions do they take to minimize risk, or, conversely, what actions do they take that give preference to other benefits over risk minimization?

It has long been thought that peasant and small holder farmers are quite conservative and risk averse (cf. Winterhalder 1990, Cashdan 1990, Barlett 1980). This was seen as an explanation of why such farmers often do things that are economically or agronomically inefficient (McClosky 1975, Winterhalder 1990). The theory is that farmers are willing to sacrifice efficiency for security (McClosky 1975, Winterhalder 1990, Ortiz 1976) and are unwilling to sacrifice security for the potential returns of untested technologies (Cancian 1980, Cashdan 1990). This idea helped, for example, to explain the inefficient but "persistent" common field system in England (McClosky 1975), or why farmers sometimes do not adopt new crops or other technologies that could increase their productivity (Cancian 1980). It was further assumed that there was a more or less inverse relationship between farmers' wealth and their aversion to risk (Cancian 1980). Because poorer farmers are less able to absorb losses, they are less likely to take risks.

More recently, the question of whether farmers are risk averse has been seen as more complex, and the answer to that question is often given as "sometimes" or "it depends". Roumasset (1979), for example, distinguishes between the risk of not maintaining levels of production sufficient to provide for a farmer's family's subsistence and the risk of production falling below some "disaster level", such as being unable to fulfill social obligations. He argues that farmers are likely to be risk averse even when they are not likely to fall below subsistence levels of production if a risk might result in such a disaster. Winter (1971) discusses the idea of satisficing; he shows that some actors make choices in order to reach a certain level of satisfaction rather than to maximize their profits. Farmers who choose to pursue satisficing rather than maximizing strategies will have less incentive to take risks that might increase profits.

Cancian (1980) reports that the relationship between farmers' risk aversion and prosperity is not strictly inverse. He has found that in many cases of technology transfer, farmers who are moderately wealthy are less risk averse than those who are more wealthy. His explanation is that in many cases there is some sort of social safety net that will prevent a family from starving. When this risk is removed, farmers calculating risk place more importance on how choices might affect their social status. The wealthiest farmers have little status to gain and much to lose, and are therefore more risk averse than moderately wealthy farmers who can still rise through the social ranks and will not fall as far if they fail in some risky venture.

Ortiz (1976) describes coffee farmers in Colombia who are both risk takers and risk averters. She finds that a farmer's aversion to risk can vary depending on his immediate circumstances. These farmers will not take risks that endanger their subsistence. Beyond that, their level of risk aversion varies, and is largely dependent on their estimates of coffee or other cash crop prices. These price estimates are not precise predictions of so many dollars per pound; instead, they are "rough calculations" along the lines of "good" and "bad" prices. Furthermore, these price estimations are more likely to consider the price level necessary to reach a certain level of satisfaction rather than to maximize profits.

It seems then that the answer to the question, "Are farmers risk averse or risk prone?" is indeed, "It depends." Farmers consider many factors when making crop decisions. In addition, farmers are, of course, not all the same; their households and farms are different, their economic situations vary as do their social statuses, and each has his or her own personality. What one farmer sees as too risky to try, another might see as a good bet. Furthermore, a farmer's situation may vary over time, and what he thinks is safe enough today, he might decide is too risky next week or next year.

Throughout the world, farmers use diversification as an insurance against various types of risk (Lucas 1997). This diversification can take a number of forms: fields scattered across a wide area, fields of varying types, cultivation of a variety of food and cash crops, and the inclusion of off-farm income (Baksh and Johnson 1990). By diversifying, farmers attempt to minimize the risk of suffering a total or near total loss (Lucas 1997). McClosky (1975) demonstrated how the fragmented fields in the English common field system reduced the risk that localized failures would include any farmer's entire crop. Winterhalder (1990) demonstrated how McClosky's theories can be applied effectively to other smallholder systems. Gladwin (1980) posits that farmers will always implement a diversification strategy if they have access to the necessary land, labor, and other resources. Lucas (1997) describes how farmers in the Lupembe area of eastern Njombe do just this. However, as Lucas (1997) also notes, farmers within a community do not all have equal access to the resources necessary for diversification, and they therefore deal with risk differently.

In her study of farmers in Lupembe, Lucas (1997) found that the methods and extent of diversification varied among farmers within a single village. She found a number of factors that influenced individual farmers' decisions concerning diversification, but these can be consolidated into three broad categories. The first is farmers' access to the means of diversification. The simplest example of this would be if a farmer does not have access to additional land where he might expand his holdings, he will not increase his diversification by increasing the area he cultivates. The second category is farmers' perception of the risk posed by a hazard. Lucas found that farmers did not always agree on the threat posed by various hazards, even such basic environmental threats as drought and hail, and those farmers who perceived a greater risk were more likely to diversify in some way. The final category is farmers' perception of the risk reducing benefits of various strategies. Lucas reports that this perception of benefit has some influence on farmers' risk reduction strategies.

In the context of this study, it will be important to examine all three of these categories of factors affecting the decision-making process. Not everyone in Mhaji has unlimited access to the resources necessary to begin coffee cultivation. Some might not be able to consider coffee a viable option at all; others will need to weigh the risks and possible benefits of coffee cultivation and other uses of resources. In Mhaji coffee can be both a way to alleviate risk and a risky venture that might provide good returns. Farmers' perception of the riskiness of coffee and its ability to reduce risk will be important in their decision-making processes.

Chapter Five: Methods

This research was conducted concurrent with my service as a Peace Corps volunteer. This played a role in determining the direction of the research as well as the methods used. The study site was determined by the location of my Peace Corps site. The study itself grew from my work, and the methods used were chosen to take advantage of benefits arising from my position as a volunteer and to ensure that the research would complement rather than interfere with that work.

The research consisted of three stages. The study began with a preliminary assessment of the local farming system and the identification of seemingly important variations in that system. Based on the foundation of this preliminary work, three of these variations were selected and examined more closely. Finally, this examination of farming system variations throughout the community was supplemented with interviews of key informants. While the interviews of individual farmers began well after the second phase, these two phases continued concurrently.

The primary research technique used throughout the study period was participant observation. Bernard (1995) describes participant observation as "establishing rapport in a new community; learning to act so that people go about their business as usual when you show up; and removing yourself every day from cultural immersion so you can intellectualize what you've learned, put it into perspective, and write about it convincingly" (137). By becoming accepted as a member of the community, the participant observer is able to reduce the problem of "reactivity", or people acting differently because they know they are being studied; the researcher becomes "ordinary", and people are not as consciously aware of being studied. Furthermore, once the participant observer has become immersed in the culture, he is able to better understand it and can ask questions an outsider might not consider, and he is able to ask these questions more clearly. In short, the participant observer's understanding of and acceptance in a culture adds to the validity of his observations (Bernard 1995).

In many ways Peace Corps service serves as a perfect platform for this type of observation. Learning the local language and becoming integrated into the community are vital to the success of both. Peace Corps service provides an entry to the community and a role for the volunteer/researcher within the community, allowing him to become a part of the community and establish the necessary rapport and "ordinariness" more easily. In my case, my roles as a Peace Corps volunteer and a participant observer were complementary. In order to be effective as an agroforestry extension worker, I needed to learn about the community and its farming systems; thus my Peace Corps work contributed to my research, and my work benefited from what I learned through my research.

The initial phase of the research consisted of simple observation and analysis of the farming system supplemented with informal interviews of a large number of villagers and unstructured interviews with two key informants. During the course of my Peace Corps work and my daily life in Mhaji I would observe such things as crops and cropping patterns, types of trees and their locations, livestock and their uses and care, and labor patterns. Concurrent with these observations I conducted informal interviews with a large number of farmers asking general questions about farming methods and cropping patterns. I also conducted unstructured interviews with two key informants; these interviews were used to clarify points of confusion arising from my observations and the other interviews, as well as to gain more detailed information on selected topics. I did not take notes during any of these interviews. Instead, I would reconstruct conversations in writing at the first opportunity after the interviews were concluded.

Based on this preliminary investigation, I decided to concentrate on three of the observed variations of the basic farming system. These were farmers with no cash crop other than maize, farmers who grow tomatoes as a cash crop, and farmers who grow coffee as a cash crop. I was primarily interested in determining why some farmers decide to grow coffee, but at this point in the study I thought that examining tomato cultivation would provide an alternative crop that was comparable to, but quite different from, both maize and coffee. During this phase I continued to use observation, informal interviews, and unstructured interviews of key informants. I continued to gather some general farming systems information, but I also began to examine coffee and tomatoes more closely.

In the course of this closer examination of farming system variations I began to reevaluate my initial ideas about tomatoes as a crop and the value of including this in the study. I had thought that tomatoes were 1) fairly uncommon as a crop, much like coffee, 2) grown almost exclusively for cash and rarely consumed, and 3) rarely grown by farmers who grew coffee. Furthermore, I had thought that maize was grown primarily as a food crop and was sold only when there was a large enough surplus or when a farmer had a great need for cash. However, over time I found that I had been mistaken in much of this. Maize is the main food crop, but it is also common for farmers to plant some maize for the purpose of sale. Further, I learned that tomatoes were fairly common, grown for home consumption as well as for sale, and grown by many farmers who also grow coffee. Given this, the contrast between maize and tomatoes did not seem to be as significant as I had thought, and while some farmers may need to decide between coffee and tomatoes, many can choose to grow both. I decided that including tomato farmers in the study would not shed as much light on farmers' decisions about coffee as I had hoped, and in order to use my time more efficiently, I eliminated the consideration of tomato farmers from the study.

The third phase of the study consisted of semi-structured interviews of seven key informants (Figure 27). Bernard (1995) discusses the value of key informants and their ability to provide quality information. He states that even a few such informants can provide "adequate information about a culture" (165), provided they are well chosen and not asked to provide information beyond what they know. Harris (1996), Clark, *et al* (1999), and Bliss and Martin (1989) provide examples of how interviews of a small number of key informants can reinforce wider studies of cultures.

Figure 27. Some of Mhaji's farmers, typical of those who served as informants.

The choice of key informants was based primarily on my confidence that they would feel comfortable discussing their families and farms with me and my confidence that I would be familiar enough with them to be able to evaluate the quality of the information they provided. Most of the villagers whom I felt met these criteria were my neighbors and people with whom I had worked in the course of my Peace Corps work.

This combined with the small number of informants to create the potential problem of choosing informants who all represented a single viewpoint, leading to the collection of data suggesting that the entire community shares the biases of that viewpoint. I attempted to minimize this problem by choosing as diverse a group as was possible. However, because the number of informants was so small, the amount of variation is not large, and the problems inherent in this must be addressed.

Some characteristics of the key informants are shown in Table 3. The names given in the table and used throughout this chapter are pseudonyms, and some details have been altered slightly to protect the informants' identities. The table shows that the key informants represent a variety of ages, levels of education, and farm sizes. Other characteristics do not demonstrate the same amount of variety. Three characteristics that do not include satisfactory variety have the potential to be particularly troublesome and must be addressed in some detail.

All of the key informants were male. This was largely because I did not feel that I could gain the necessary rapport with many women in Mhaji. This is not a problem, however. While there are some female heads of household in the village, the vast majority of households have male heads. Furthermore, while farmers' wives have some input in agricultural decisions, the major decisions are generally made by the head of household. Consequently, the focus on "producers" rather than households, while not gender sensitive, should not detract from the validity of the data concerning those decisions (Jansen 1998).

Five of the key informants were farmers with whom I worked in my role as a Peace Corps volunteer. These farmers are characteristic of those with whom I worked in

Informant *	Age	Level of Education	Number of Wives	Number of Children	Area of Upland Fields	Area of Valley Gardens	Off-Farm Income?
Babu**	54	Post-secondary Degree	1	7	6.5 acres	0.25 acre	Yes
Mzee**	53	Standard Eight	1	6	5 acres	1 acre	Sometimes
Bahati**	40	Standard Two	1	7	4.25 acres	0.25 acre	Yes
Baraka	32	Standard Eight	1	5	3 acres	3 acres	Yes
Juma	40	Standard Three	2	6	1.5 acres	3 acres	Yes
Fundi	35	Standard Eight	1	4	3 acres	4 acres	Yes
Kijana	22	O-level Finisher	0	0	1.5 acres	1 acre	No

*Psudonyms used to protect informant's identities.

**Indicates coffee growers.

Table 3. Characteristics of the Key Informants.

that they sought out my advice under their own initiative. This suggests that they have positive attitudes concerning extension agents or innovation, and I felt from the beginning that such attitudes might be important factors in farmers' decisions concerning coffee. However, there is not a complete lack of variety among the informants concerning these attitudes. Two of the five key informants with whom I worked are not coffee growers; furthermore, the informal interviews were conducted with a wider variety of informants, including many with whom I did not work. With this limited variety and careful consideration of this possible bias in the data during analysis, any bias in the interpretation of the results can be avoided.

The characteristic lacking variety that is the most problematic concerns farmers' wealth. It seems likely that the poorer residents of Mhaji are under-represented in the study, and the poorest of the poor have likely been missed entirely. This is somewhat difficult to judge because the study did not include any direct investigation of farmers' wealth, and, consequently, any evaluation of an informant's wealth is based solely on my familiarity with the informants and the community. Wealth was not a topic that was openly discussed by many villagers, and this made learning about the topic difficult. However, rough estimates of relative wealth are possible. Based on these estimates, only one of the key informants could be considered even moderately poor, and few of the informants included in the informal interviews were poor. Again, careful consideration of this flaw in the selection of informants minimizes its effect on the validity of the data. Furthermore, as will be discussed in the next chapter, many of the farmers who were interviewed were concerned with the cash investments required to plant coffee. From this it can be inferred that the poorest farmers are not able to consider coffee cultivation at all; the cash investment is simply too large and beyond their means.

In preparation for the semi-structured interviews I constructed an interview guide based on previous observations and informal interviews. This guide consisted of a list of questions to be included in each interview. The questions included general household information, farming system information, and attitudes concerning coffee, agricultural innovation, and extension agents (Table 4). The topics included in the interview guides were chosen based on my knowledge of coffee and its requirements, potential benefits, and potential dangers, my observations of the local farming system, and the previous informal and unstructured interviews. The interviews were conducted at either the informant's home or my home, depending on the informant's preference. Topics were discussed in roughly the same order in all the interviews; however, informants were free to elaborate and digress if they felt it was appropriate, and this led to some variation in the order topics were discussed. Notes were taken during the course of the interviews, but no attempt was made to compile complete transcripts. For examples of similar combinations of methods see Jansen (1998), Schwartz (1990), and Creed (1998).

Throughout the course of the study I performed some preliminary analysis of the information provided through interviews. I attempted to begin isolating those factors that are most important in forming farmers' crop decisions in two ways. The first of these methods was identifying patterns of factors that were mentioned by many farmers. The second was paying particular attention to those factors that some farmers seemed to give special importance. No potential factors were eliminated from the study through this

Table 4. Summary of questions asked in semi-structured interviews.

Household information	**Trees**
Gender	Species grown
Age	Locations of trees
Religion	Uses of trees
Place of Birth	Number of each species (or area planted)
Time lived in Mhaji	Are trees planted or natural regeneration
Amount of Education	**Livestock**
Number of wives	Types of livestock kept
Number of children	Number of each type
Ages of wives and children	Uses of each type
Where children live	**Extension agents**
Is the household food self-sufficient	Which agents have been consulted
Is there any off-farm income	How often are they consulted
Field information	Did the farmer seek them out
Number of fields	Why were they consulted
Size of fields	Ranking of willingness to approach them
Distance from home	Ranking of agents helpfulness
Access to water	**Agricultural innovation**
Soil type	Has the farmer tried innovation in the past
Normal crop on each field	Does the farmer like to try new things
Crop information	Reasons for liking or disliking innovation
Crops grown, area planted	**Coffee (if applicable)**
Which crops are sold for cash	When farmer first planted coffee
Is there any use of mixed- or multi-cropping	How much area planted to coffee
Are any fields irrigated	Coffee's advantages and disadvantages
What inputs are used	Why did the farmer decide to plant coffee
Labor information	Does the farmer plan to continue
When are tasks performed	Farmer's rating of liking coffee
Who performs what tasks	Farmer's rating of field suitability
Times of labor shortage or excess	
Is any hired labor used	

preliminary analysis. However, this analysis did help to shape later stages of the study, particularly the guide for the semi-structured interviews.

More thorough analysis was performed after I had returned from Tanzania. This analysis consisted of three parts: analysis of statements made in interviews, both unstructured and semi-structured, a separate analysis of observations of farming systems and more general household and personal factors, and finally the synthesis of these two analyses and the determination of the importance of various factors in farmers' decision making processes.

The first of these parts is the more straightforward. I examined the notes of the interviews and coded statements based on the categories in Table 5. These categories were chosen through a process that combined my observations of the farming system and farmers' decisions and my preliminary analysis of the data. I created a preliminary list of categories based on my observations of the farming system, including the factors that I thought might be important in determining coffee's suitability for individual farms and its acceptance by farmers. I refined this list during my initial analysis of the data, adding, removing, and modifying categories based on what types of statements seemed common.

The statements were not coded based on what they said about a topic, but simply what topic they addressed. For example a statement about how concerns about food security affect decisions about coffee would be coded as "Food Security", as would a statement that food security plays no role in those decisions. Statements could be coded more than once; a statement that described how the price of coffee might affect food security, for instance, would be coded as both "Coffee Markets" and "Food Security". The length of statements was not considered, and a single, short sentence about a topic was given the same weight as a longer description. However, if an informant made similar statements on multiple occasions, each occasion was coded separately. Further, if a longer statement concerned multiple, distinct aspects of a topic, the statement was considered as multiple statements. An example of this would be if an informant discussing food security mentioned that coffee requires a reduction in the area planted with maize *and* that coffee has no food value.

The coded statements were then examined for the presence of any patterns in which factors were mentioned frequently and if those factors were mentioned as reasons for growing coffee, reasons for not growing coffee, or as unimportant factors. Because the sample size is so small and because the majority of the data came from unstructured interviews with no assurance that all factors were equally likely to have been given consideration, no attempt was made to quantify the number of statements in each category beyond such general statements as “many” or “few”.

Table 5. Categories used in coding statements.

Food Security	**Benefits of Coffee**
Initial Investment	Potential profits
Labor	Permanence
Cash	Hardiness
Land	**Labor**
Coffee Markets	**Uncertainty of Performance**
Insecurity	**Extension Agents**
Good Price	**Innovation in General**
Suitability of Fields	**Exposure to Coffee**
Use of Other Trees	**Access to Cash**

The second part of the analysis was an attempt to examine some of the factors that I had observed and considered to be potentially important in farmers’ decisions, but which were not addressed completely by the interview data. Some of these factors were farming systems information, such as the suitability of farmers' fields for coffee cultivation; other factors were personal information about farmers, such as their exposure to coffee cultivation in other locations in Tanzania. The data used in this phase of analysis came largely from my familiarity with Mhaji and its people, for example which families are related, who is a friend of whom, and personal histories of informants. I would identify an observation that had been mentioned rarely or not at all during interviews, such as many coffee farmers seem to have had some connection to other coffee growing areas. I would then examine my notes systematically to determine if the observation was valid or if I had simply overlooked data which does not support the observation.

The final step in the analysis of the data was the placing of potentially important factors into three categories: those factors that appear to be important in farmers' decisions about coffee, those that appear to be unimportant, and those for which the data is inconclusive. Given the qualitative nature of the data, this step of categorization was necessarily subjective. However, I was careful to remain conservative in my evaluation of the coded data. Factors were only classified as either important or unimportant when the data proved to be conclusive. If for a given factor the coded statements and my observations overwhelmingly supported the placement of the factor in one of these categories, then the factor was categorized this way. If, however, the coded statements were not conclusive, and my observations and familiarity with the community could not be used to explain why the seemingly inconclusive data supported the factor's categorization as important or unimportant, then the factor was placed in the third, inconclusive category. Similarly, if my observations concerning a factor were not conclusive and the coded statements did not provide a means of interpreting that data one way or the other, the factor was place in the inconclusive category.

This combination of analysis techniques allowed me to synthesize the data collected through both types of interviews as well as through general observations. The final, simplified categorization allows for a straightforward interpretation of the results. These results are presented in the next chapter.

A Note on Data Quality

One problem with relying on informants is that they sometimes provide misinformation, either by making mistakes or by lying (Bernard 1995). An informant might make a mistake because he has forgotten something or is misinformed about a topic. He might lie in order to tell a researcher what he thinks the researcher wants to hear, to describe something as it is supposed to be rather than how it is, or because he fears what might happen if he tells the truth and is later identified as the source of the information.

I am certain that some of the data I collected through informant interviews is inaccurate for these reasons. However, this should not undermine the overall validity of the study. One of the benefits of relying on participant observation as a research method is that the researcher can gain sufficient understanding of the culture and enough familiarity with the informants to detect most such inaccuracies and interpret them (Bernard 1995). I have done this, and when I report such data, I will make note of it and discuss its validity.

Chapter Six: Results and Discussion

In this section the study results are presented and discussed. The results are presented in three sections. First the factors that seem to be important in farmers' decisions concerning coffee are discussed. This is followed by a discussion of the only factor, land tenure, that definitely does not seem to affect these decisions. Finally, factors for which the data are inconclusive are presented and discussed.

Important Factors

There are a number of factors that are important considerations for farmers when they are making decisions about cultivating coffee. Ensuring food security is the first factor most farmers in Mhaji consider when making a decision about coffee, but a cursory examination of the data does not reveal this. The most common statements concerning food security suggest that it is a non-issue. When asked about his own household's food security, informant Mzee stated that "It is difficult to go hungry in Mhaji." Many farmers agreed with this statement, and others claimed that "only lazy people" ever go hungry there. However, other statements seem to qualify this.

Farmers are aware of how much maize they can expect to harvest from their fields. If converting a field to coffee production will lower a farmer's potential harvest to a level that might endanger his household's food security, then he will not do so. For example, when a farmer who planted two acres of coffee was told by others that they were surprised that his wife would allow him to replace that much maize with coffee, he explained that the new coffee plantings were split among two fields, each dedicated to supporting one of his wives. He went on to say that if he took that much area away from the maize of just one wife, she would never allow it. Furthermore, both Juma and Kijana stated that they could not seriously consider planting coffee because they did not have enough land and could not reduce their maize acreage without endangering their food security. The MCGA strongly encourage members to plant one-half acre of coffee each year until they had planted one to two acres, and this relatively large area was a common concern of farmers who were considering coffee as a crop.

While no farmer would convert so much area to coffee that it would be impossible for him to meet his family's need for food, any reduction in the area dedicated to food will increase the risk to the family's food security. Even if the farmer can still expect to produce a surplus, that surplus will be smaller, and the family's margin of error will be smaller. In addition to predicting the amount of food his family will need each year, a farmer must predict the likelihood of failure, the probable severity of any failure, and the surplus production necessary to compensate for failures. Decreasing his potential surplus maize production by converting to coffee increases the risk that a failure will result in the farmer not producing enough to feed his family. When considering planting coffee, a farmer must assess this increase in risk and weigh it against the potential benefits of coffee.

A second basic factor in farmers' consideration of coffee is the initial investment of cash required to purchase planting stock and inputs. This can be quite expensive. Some farmers who consider planting coffee are unable to afford it, and others who can afford the investment choose to use the money for other purposes. Both Fundi and Baraka mentioned this as reasons why they have as yet planted other cash crops rather than coffee, even though they would like to plant coffee eventually. Many other farmers stated that this was a problem for them. Concerns about the start-up costs of coffee cultivation were common topics for discussion at the early meetings of the MCGA; a majority of the people who attended early meetings and then chose not to plant coffee had displayed some apprehension about these costs. Further support for this can be found in the fact that just over two thirds (24 of 34) of the individual members of the MCGA have some form of off-farm income. This large investment increases the risk a farmer faces in two ways. First, when a farmer uses cash to invest in coffee, he then has less money to use for other things. This increases the chance that he will not be able to afford any unexpected expenses. Second, the size of the investment raises the chance that a failure of the coffee crop will be disastrous. By increasing the potential loss, this in effect increases the risk involved in coffee cultivation.

Another factor, the labor required to plant coffee, is closely related to the initial monetary investment. This is because many households do not have access to enough labor to dig the large number of planting holes in a timely manner (Figure 28). A single adult can be expected to dig between five and twenty holes per day, depending on soil conditions and the amount of time dedicated to the task. At the normal spacing 530 holes are needed per acre; even planting only half an acre per year can stretch the limits of most households' labor resources. Consequently, many farmers must either depend on purchased or communal labor. The informants Babu, Mzee, and Bahati all talked of the problem of labor for digging planting holes. Babu had attempted to dig the holes for one acre using only family labor, but he had to hire someone to help in order to finish on schedule. Mzee and Bahati had both used family labor in the past, but they procured hired labor to dig the holes for their newest coffee plantings. Bahati had only planted one half acre rather than the full acre he had planned to plant, because he was unable to afford to pay laborers for the full acre. The ability to purchase labor seems to be as important as the ability to supply enough family labor to plant a coffee field. Much like the investment of cash, the investment of labor increases risk by making the potential failure of coffee more costly, particularly if labor is purchased.

Figure 28. Digging holes for planting coffee is laborious.

A very common concern among farmers considering coffee is the uncertainty associated with the coffee market. By far the most common comment made about the coffee market was that farmers had heard that the market is "not very good" and that they worry that prices are will be too low for the crop to be profitable. Similarly, farmers' unfamiliarity with coffee and their limited ability to predict its performance plays a role in farmers' decisions. While relatively few informants specifically cited this type of concern, and the importance of this factor is not directly evident, there is some indirect evidence that suggests this is an important factor.

Farmers can look at the coffee market's effect on risk in two ways. Because they are not familiar with the market and have no way to predict coffee prices beyond trusting extension agents, farmers face increased risk. Furthermore, what they do know of the market is often that it is volatile and prices are often low, further evidence that coffee will increase risk. However, the markets for existing cash crops are not strong: in 2000 a number of farmers were unable to sell their potatoes, and many sold maize for less than one dollar per 100 kilograms. At this price, a farmer could expect to sell a good maize crop for less than he could earn with a bad coffee crop at a similarly bad price. From this viewpoint, a farmer might see relying on the coffee market as a decrease in risk.

Farmers who have never cultivated coffee must rely on those who have and on the advice of extension agents when assessing the risk associated with unfamiliar markets and predicting how the new crop will perform. Reliance on other farmers often depends on personal relationships. For example, Bahati and Mzee both have relatives in another region of Tanzania where coffee has been grown for some time, and other coffee farmers have similar connections to coffee growing areas in other parts of Njombe as well as farther afield. Babu has a neighbor who has begun growing coffee recently after having asked Babu about coffee. Many of the coffee farmers in Mhaji live close to each other; Foster and Rosenzweig (1995) describe how technology transfer can occur through "spillover" from neighbors, and it seems likely that this has happened here to some extent. Babu himself is friends with Mzee; friendship is a common relationship among coffee farmers in Mhaji. There are a number of coffee farmers who are quite excited by the crop and their friends are likely to hear about the crop and its benefits.

In addition to this informal "spillover" learning from neighbors, farmers also depend on more formal exchanges of information. In 1999 members of the MCGA traveled to Ninga, a village in eastern Njombe, and the Ugano Coffee Research Institute in Mbinga Region to receive training in coffee cultivation. Both of these trips were funded with grants from the Peace Corps/US AID Small Projects Assistance fund, and the farmers were accompanied by government and Peace Corps extension agents. However, a large portion of the training during each trip was performed using farmer to farmer extension methodologies (Selener, *et al* 1997). In this methodology, the people who act as trainers are themselves local farmers who have been trained in the past. Each of these trips was then followed by similar farmer to farmer seminars in Mhaji. The farmers who participated in these trips became some of the most enthusiastic coffee growers, and many of them stated that their enthusiasm came partly from seeing that “regular farmers” and not just rich or technically educated farmers were able to cultivate coffee successfully. Similarly, when these farmers then acted as farmer promoters in Mhaji, many other farmers expressed the importance of knowing that someone had seen in person that the theories of various extension agents do work.

The best sources of technical information about coffee in Mhaji are the extension agents. Mhaji is lucky in its extension agents. There are two who live in the village, a married couple responsible for serving a number of villages in the area. One of these two is originally from Kilimanjaro Region, and, therefore he is familiar with coffee cultivation and its potential. The village is also served by the Njombe District coffee officer who is knowledgeable about coffee and a talented extension agent. In addition to these Ministry of Agriculture officers, until September 1999, the district coffee officer worked in conjunction with a cooperative and marketing extension agent from the Irish Fund for Cooperative Development, and Mhaji will have a Peace Corps volunteer until at least 2004.

With all of these extension agents, farmers have ample access to advice from people knowledgeable about coffee, and they seem to have faith in the advice they receive from those people. All of the key informants stated that they utilize all of the extension agents regularly and that the agents are helpful. Of course, this could be a case where the informants were not entirely truthful as I was one of the extension agents in question. However, I am certain that the local and district extension agents are well respected, and most of the time their advice is considered good. Farmers frequently sought out the advice of extension agents and eagerly attended seminars conducted by them, and they normally followed the advice of the agents and implemented what they learned at seminars. For example, after the two local extension agents held a seminar on composting crop residue as an alternative to burning it in the fields, the MCGA instituted a requirement that its members practice composting, and composting pits began to appear on the farms of members and non-members. Farmers with sick livestock regularly sought out the extension agents for advice, and this kept one or the other of the two who live in Mhaji traveling almost constantly. This faith in extension agents is true for many farmers who do not grow coffee as well as those who do, but all of the farmers who expressed or demonstrated that their opinion of extension agents is low were not coffee farmers. Further, all of the coffee farmers work closely with the extension agents, and appear to listen to them and trust their advice. This suggests that the farmers who have the least confidence in extension agents are more likely to decide against growing coffee due to the uncertainty inherent in unfamiliar markets and crops.

There is always some risk inherent in trusting the advice of others, whether they are extension agents or neighbors with experience with coffee. A farmer must assess the chance that his advisor will be wrong. He must also consider that increasing his store of knowledge by utilizing the knowledge or experience of others can allow him to make better predictions about coffee, thus reducing the risk involved in its cultivation. This composite risk must then be evaluated and considered when the farmer makes his decision to grow coffee.

Coffee's hardiness and permanence are another factor important to farmers. Babu explained that with maize, "if there is a shortage of rain—failure, if you are late weeding—failure, if you fail to fertilize enough—failure," while coffee is able to endure these hazards and will yield something in all but the very worst years. Farmers stated again and again that they like this characteristic of coffee. They also frequently stated that they like coffee because it does not need to be replanted every year and that it can produce for decades without replanting. Many farmers said that they were interested in growing coffee partly as a legacy for their children; one of the MCGA's stated goals is to ensure that the families of its members will be able to continue to care for the coffee should something happen to the members themselves. Not all farmers perceive the same insurance value in coffee cultivation. Juma, for example, stated that he does not believe that coffee is any better than maize in its response to environmental hazards. As Lucas (1997) demonstrated in eastern Njombe, this perception of the insurance value of agricultural practices influences farmers' decisions concerning them.

There is one final factor important in farmers' decision-making process that is difficult to define precisely. I will call this factor farmers' personal preferences. This factor includes various attitudes that do not necessarily have a place in the model of a rational actor. There are two strong examples of this type of factor in the data, and it seems likely that there are others. The first example is a coffee farmer who also has a large number of fruit trees. This man stated that one of the main reasons he cultivates these trees is that he simply likes trees and enjoys caring for them. It seems reasonable to assume that there might be other farmers who feel this way, some who might not grow coffee because they dislike trees, and perhaps some who choose another crop over coffee due to some special fondness for, say, potatoes. The second example of this type comes from two key informants, Babu and Baraka. Both of these farmers stated quite strongly that they like to try new crops, agricultural techniques, and technologies. They each had experimented with a number of cash crops in the past, at least partly for the sake of just trying something new. Babu in particular placed some value on innovation itself separate from any other potential benefits of a new crop. It is possible that such personal preferences might override considerations of risk to some extent. For example, the farmer who enjoys growing trees might feel that the enjoyment he gains from the activity is worth the loss that might come from a failed crop. Similarly, a farmer who likes to try new things might feel that the experience of trying new crop is worth some potential loss.

Unimportant Factors

Land tenure is the one factor that I found to be unimportant in farmers' decision making. This is simply because most farmers are not aware of the national land policies and act as if they have secure traditional usufruct rights. Only one resident, one of the agricultural officers, ever stated that he knew of legal land titles, and on several occasions I heard him describing this to farmers, most of whom did not seem to understand that legally their land tenure is not secure. Under the traditional system, a farmer who plants trees along the boundaries of his field and a farmer who has planted coffee or another permanent crop throughout the filed have secured their tenure equally. Because there is little or no perception of risk related to tenure and no perceived benefit to planting coffee rather than other trees, farmers have no motivation to act in response to that risk. Therefore, tenure and risk related to tenure are unlikely to influence a farmer's decision concerning coffee.

Other Factors

For a number of factors considered in this study the evidence concerning their effect on farmer decisions is not conclusive. In some cases this is simply because there is not enough data to support any conclusions. In other cases, there is no direct evidence that the factors are either important or unimportant, but there is some data that might be interpreted as providing indirect evidence. In a few cases, the data are contradictory, with some suggesting the factors are important and some suggesting they are not.

Many farmers, both those who grow coffee and those who don't, mentioned that they do not like the length of time between planting coffee and the first harvest. However, many of these same farmers, even those who had chosen not to grow coffee, were willing to plant small woodlots of *Acacia mearensii* or *Pinus patula*. Both of these species require a longer period between planting and harvest than coffee does, approximately 10 years for *A. mearensii* and 15 to 25 years for *P. patula*, compared with three to five years for coffee. Although *A. mearensii* is grown for household fuelwood, both of these trees are grown for sale and are not a significantly different type of crop. Therefore it is difficult to say why so many farmers are willing to dedicate a field to one of these species for 10 to 25 years but are reluctant to wait three to five years for coffee to mature.

Farmers' attitudes toward cooperatives is another factor with ambiguous data. Babu reported that in the past he had bad experiences with cooperatives, in particular the cooperative that was a part of the Bena Wattle Scheme, but at the same time he was one of the most enthusiastic members of the MCGA. This appeared to be common; many residents of Mhaji expressed dissatisfaction with cooperatives of which they had been members, but at the same time were willing to join agricultural cooperatives. Contrarily, Juma described a positive experience with a small cooperative raising chickens, but he was reluctant to join another cooperative. Again, this was not an isolated attitude, although it was not as common as the former.

This question of cooperatives includes two aspects of risk. There is the risk that the cooperative will be plagued with corruption, specifically the misuse of group funds, or free riders, members who profit from the cooperative without doing their fair share of the work. Conversely, by pooling resources, especially labor and cash, the cooperative can act as insurance against the risk of a shortage of either. The ambiguous data concerning cooperatives is likely due to farmers' different perceptions of these two aspects of the factor. It is also possible that something other than past experience with cooperatives affects these perceptions. For example, a farmer who has had good experiences with cooperatives might feel that the members of a new cooperative are untrustworthy; thus, he could think that this cooperative is too risky while at the same time believing that cooperatives in general are risk reducers.

A third factor that is ambiguous is the role of satisficing. Juma stated that part of the reason he is not interested in growing coffee is that his income "is enough." This could be interpreted to mean that Juma is an example of a farmer who pursues a strategy of fulfilling a certain level of satisfaction rather than one of maximizing his returns. If this is true, it is likely that he sees no need to take even a small risk to increase his income, because, quite simply, he is happy with what he has. However, there is very little other data that is relevant to this question, and it is not possible to generalize beyond Juma himself.

The final factor for which the data are inconclusive is coffee's potential to improve the productivity and sustainability of the local farming system. This factor is notable for the almost complete lack of data directly associated with it. This implies that farmers do not consider this aspect of coffee when making crop decisions, and it is likely that this is true. However, there are some pieces of data that can be interpreted to suggest that farmers do consider this aspect of coffee when making decisions.

In general, farmers seem to be largely ignorant of such things as nutrient cycling, the importance of organic matter in soil, and the potential to increase production through multi-cropping. This type of information is widely taught in those secondary schools that include agricultural programs (Sikauki 1999), but it is rare for villagers to attend secondary school. Other opportunities to learn about such things are limited. Extension agents discuss these issues some, but this is not common. Farmers are, of course, aware of the importance of fertilizers in maintaining the productivity of their fields, but they do not seem to realize the role that farm management practices can play in maintaining soil fertility through other means. The informants Babu and Kijana both demonstrated some more advanced knowledge of soil fertility management, but they did not discuss this in relation to coffee. These two informants also expressed some knowledge of the benefits of mixed cropping, as did a few other farmers in the area. Mixed cropping, particularly combinations of beans and maize, is common in Mhaji, but it is unclear if most farmers who do this recognize that it can increase production or if it is simply “the way things are done.”

While these data seems to suggest that few farmers, if any, recognize the potential for coffee to raise the productivity and improve the sustainability of the local farming system, other data can be interpreted to suggest that they might. For example, farmers who like coffee because of its hardiness and permanence could be in part recognizing coffee’s effect on the sustainability of the system. Similarly, farmers who appreciate the potentially high prices for coffee might be seen as considering the potential for coffee to raise production. However, there simply is not sufficient data to evaluate this possibility.

Chapter Seven: Conclusions and Recommendations

The process through which farmers make agricultural decisions is complex. Farmers consider many factors, and in many cases these factors are not entirely separate, but interact and influence one another. Furthermore, each farmer has a unique personality and examines these factors from a unique viewpoint. This is true of farmers in Mhaji, and it is not possible to state why all farmers make the decisions they do. However some generalizations can be made.

This study has shown that when farmers in Mhaji decide whether or not to begin raising coffee they do not consider land tenure. Some other factors are important: preservation of food security and the initial investments required by coffee are particularly so. These factors prevent some farmers from even considering coffee cultivation as a possibility; farmers must have a combination of land, labor, and capital sufficient to allow them to make the necessary investments and to dedicate some land resources to coffee production and still provide enough maize to supply their household with food. It is only after meeting this threshold that farmers can consider coffee production and make decisions based on the risks and benefits of coffee. Market issues, the advice and experience of extension agents and other farmers, the hardiness and permanence of coffee as a crop, and personal preferences are also important. The importance of many factors is left unclear by the data collected in the study, and it is not unlikely that some potentially important factors have not been considered at all.

In isolation, even the factors that are important do not reveal any pattern. However, when they are examined together within the framework of risk and uncertainty, the importance of risk in farmers' decision-making processes is evident. Coffee can act as both a method of reducing the risk a farmer faces and as a risky venture that might result in either an increase or a decrease of returns. Farmers must weigh the various risks and benefits of coffee when evaluating its potential to improve their farming systems.

It is important to remember that how farmers react to risk is dependent on the environment in which they are making their decisions. It may be safe to say that farmers throughout the world consider risk when making decisions. It may even be safe to say that farmers throughout the world react to risk by diversifying. However, in more specific questions of decisions made by farmers, close attention must be paid to the geographic, climatic, cultural, and historical context within which those decisions are made. Without this examination of context, it is difficult to explain why, for example, the farmers whom Ortiz (1976) studied in Colombia make different decisions concerning coffee than the farmers in Mhaji, or why the farmers Lucas (1997) studied in eastern Njombe have reacted to the agricultural risks in the area by planting tea while farmers in Mhaji have chosen coffee. Furthermore, as Ortiz (1976) and Lucas (1997) both demonstrate, farmers can be risk takers and risk averse depending on their immediate circumstances. Without considering this aspect of farmers' reaction to risk, it would be difficult to understand why some farmers in Mhaji did not adopt coffee when it was first introduced and then decided to plant coffee ten years later, or why some farmers in the village have chosen to cultivate coffee while others have not. Perceptions of risk and reactions to exposure to risk vary among cultures, among communities within a culture, and among individuals within a community. Only by understanding the cultural and individual contexts within which farmers make their decisions can we understand the role of risk within those decisions.

Recommendations for Further Study

Given the complexity of the role of risk in farmers' decisions about coffee, this study can only act as a preliminary investigation. The results are far from definitive, and they can best be considered a baseline from which further research can extend. The results suggest some possible directions for further study that could prove fruitful.

A closer examination of the factors that remain ambiguous should be conducted. The question of why some farmers who are not willing to plant coffee because of the time between planting and harvest, but are still willing to plant other tree crops is particularly interesting. Including coffee is not the only method of improving the local farming system, and other agroforestry systems could be just as effective. Understanding what differences, if any, exist between coffee and other tree crops could prove valuable in future attempts to improve agricultural production and sustainability.

A more extensive and quantitative examination of factors important in farmers' decision-making processes would be valuable. While the present qualitative study is itself valuable, a quantitative study would allow a more precise evaluation of why some farmers choose to grow coffee. For example, the present study has shown that farmers will not grow coffee if this will reduce their expected maize yield to the point where their households' food security will be endangered. A quantitative study might be able to determine what the expected maize harvest must be before a farmer will plant coffee. Such quantitative results when combined with qualitative results would serve to increase the understanding of risk and decision making in Mhaji.

Because coffee requires several years to become established and is a permanent crop that can remain productive for decades, a long-term study of its role in the farming system in Mhaji would be valuable. Such a study could provide valuable information on two aspects of farmers' decisions about coffee that could not be addressed by this study. The first of these is how the presence of established coffee fields influences farmers who are considering planting coffee. The second is the question of whether farmers continue to cultivate coffee for an extended period. The farmers who were planting coffee at the time of the present study were generally very enthusiastic about the new crop and expressed their intentions to continue to cultivate it, but it is possible that in the future some may abandon coffee. A longer-term study would allow an examination of which farmers continue to cultivate coffee and what factors affect this decision.

Recommendations for Coffee Promotion

The introduction of coffee to the farming system in Mhaji and the transformation of that system from the current maize-based system to a more sustainable and productive agroforestry or mixed farming system has the potential to improve the lives of the village residents. Despite the volatility of the coffee market, coffee is, in the long run, likely to be a more profitable cash crop than maize. An agroforestry or mixed farming system would also be more stable and sustainable (Beets 1990). It would be best if such a system were the rule in Mhaji rather than the exception. The 35 current members of the MCGA are a start along this pathway, but it is a slow start, and the question remains, how can this transformation be accelerated without wasting resources or forcing the change on those farmers who are not ready for the change or for whom it might not be appropriate?

Given the importance of risk assessment in farmers' crop decisions, the relationship between coffee and risks faced by farmers should be the focus of any attempt to promote coffee as a cash crop. There are three aspects of coffee cultivation that can address many of the risk-related concerns, and these should be given priority in coffee promotion and extension projects. These are 1) the importance of integrating coffee with other components of the farming system, 2) the importance of cooperatives in facilitating coffee production, and 3) the long-term benefits of increased productivity and sustainability.

Ensuring that farmers integrate coffee with other components of a system addresses two of the most important risk-related concerns of farmers, food security and market uncertainty. If a farmer simply replaces his maize-based system with a system that similarly overemphasizes coffee, he will risk placing his household's food security in jeopardy. If, however, coffee is simply one of many components, the resulting diversity within the system will provide insurance against a number of threats to food security. If coffee is not overemphasized, food production can be continued at subsistence levels even in the face of partial crop failures. In addition, cash income from coffee will allow purchased foods to supplement and make up any deficit in food production. In much the same way, a diverse system which includes coffee can insure against market fluctuations. If coffee is not the only cash crop, then the odds that a weak market will be disastrous are lowered. Furthermore, the inclusion of food crops will ensure that even in the worst markets, the household will not starve. Therefore, when promoting coffee, extension agents should emphasize that coffee should not simply replace maize as the cash crop in the current system, but should be a part of the evolution from one system to another.

Cooperatives can help to minimize the risks associated with the expense of planting and caring for coffee, the high labor demands of the crop, and, to some extent, the volatility of the coffee market. By pooling their financial and labor resources through cooperatives, farmers can increase their capability to purchase inputs and perform tasks in a timely manner. By marketing their combined coffee production, farmers can command better prices; they can even sell harvests that might be too small to sell individually, a common problem in the early years of a coffee field's establishment. Given the uneven record of cooperatives in Mhaji and their bad reputation among some farmers, efforts must be made to convince farmers of the benefits of cooperatives. In addition, farmers must receive training and education about cooperatives and their management to ensure that any new cooperatives do not simply add to farmers' mistrust of such organizations. This will be particularly important as the number of coffee farmers increases, and the cooperatives become larger and more complex.

The risks associated with the coffee market are important to both those farmers who are debating whether or not to plant coffee and those who have planted coffee and must decide how best to manage it. Because farmers are unfamiliar with the coffee market, they are unable to evaluate coffee's risks and potential accurately, and they are unable to base management decisions on sound predictions of what returns they should expect. Increased education about how the market works and how it has performed historically should be included as a part of coffee promotion and extension. This will allow farmers who are considering planting coffee to make their decisions using more accurate information. It will also allow farmers who have decided to grow coffee to make their management decisions based on more accurate predictions of prices.

Finally, those planning coffee promotion and extension programs should not forget that farmers rely on their friends and neighbors when evaluating the risk inherent in adopting new technologies. While it is important that extension agents who are well versed in the technical aspects of coffee cultivation and marketing participate in these programs, the success of farmer to farmer extension should not be ignored. A combination of traditional expert extension and farmer to farmer methodologies holds the most promise for successful promotion of coffee as a crop.

The introduction of a new crop to a farming system can seem to be a large risk, particularly for smallholder farmers in the tropics who normally do not have a large margin for error. A crop like coffee, with its large investments, slow growth, permanence, and lack of food value can seem particularly risky. However, given its potential benefits, coffee need not be a large risk. If farmers are well informed through proper crop extension, and if coffee is not forced on those for whom it is inappropriate through overzealous promotion, the introduction of coffee into a maize-based system like that found in Mhaji can be the first step on a pathway to increased and sustainable productivity.

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