



THE "TREE AGAINST HUNGER"

Enset-Based Agricultural Systems in Ethiopia



AMERICAN ASSOCIATION FOR THE
ADVANCEMENT OF SCIENCE

American Association for the Advancement of Science
with
Awassa Agricultural Research Center
Kyoto University Center for African Area Studies
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**Steven A. Brandt, Anita Spring, Clifton Hiebsch,
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FOREWORD

Africa faces over the next decade an ever-increasing need to achieve sustainability in agricultural production. In the Horn of Africa one of the primary obstacles to sustainability has been the threat of famine. Yet, as this important booklet shows, there are parts of Ethiopia that survived famine during the 1980s because of the utilization of enset as part of the subsistence system. Also known as the false banana, enset is very likely the most unstudied domesticated crop in Africa. It helps to feed approximately ten million people in Ethiopia and Eritrea (in restricted pockets). Given that it figures so importantly in the diet of contemporary Ethiopians and that it has acted as a famine buffer, why has it been so neglected? The answers are complex. They are partly related to cultural perceptions, politics, and history. This short monograph unwraps much of the mystery surrounding enset. It explores its history, noting that enset was once much more widespread in Ethiopia. It also explores its food characteristics and the different agro-economic conditions under which it is grown as an important part of the diet.

Because the development agendas of Western aid agencies still focus on cereal grains, particularly maize, enset continues to be ignored. Even though the Ethiopian government has recently elevated enset to the status of a national crop, it is not clear that this move will propel critical research that is needed to realize its agricultural potential in other regions of Ethiopia. Nor does it ensure that enset remains an integral part of the subsistence systems where it is already being cultivated successfully.

Over the last seven years, I have closely followed the progress of research on enset. For the most part this research, in addition to work undertaken by Ethiopians, has been initiated and carried out by colleagues in the Department of Anthropology at the University of Florida. While initially anthropological in focus, the research has since expanded to include agronomy, soil science, economics, history, and other ancillary sciences. It has also incorporated collaborating scientists from the University of Addis Ababa, Kyoto University, the University of Colorado, and the Awassa Agricultural Research Center in Ethiopia. In this sense it is an excellent model of interdisciplinary collaboration and interaction.

In the Sub-Saharan Africa Program of the American

Association for the Advancement of Science (AAAS), we felt there was a need to disseminate the results of preliminary research conducted by the enset research team. Their preliminary research results have important implications for future agricultural development in Ethiopia, as well as for the sustainability of existing enset systems. Also, it is clear that policymakers and agricultural specialists do not understand the plant, its economic potential, its cultural limitations, its famine-buffer potential, and its threatened sustainability.

To overcome these deficiencies in general knowledge, we organized a full-day symposium in April 1997 under AAAS sponsorship at its Washington headquarters. Experts from institutions that invest in agricultural development in Africa and pertinent Ethiopian scientists were invited to participate in the symposium. Representatives from JICA, USAID, the World Bank, and Catholic Relief Services provided critical reactions to the papers presented by Brandt, Shigeta, Yntiso, McCabe, and Hiebsch. The discourse was lively and pointed. Discussion focused on a number of key issues, such as the cultural stigmas attached to enset food products, the dangers of assuming wholesale transferability of enset agriculture to other regions in Ethiopia, and problems being driven by increasing populations and shrinking farmland in some enset producing areas.

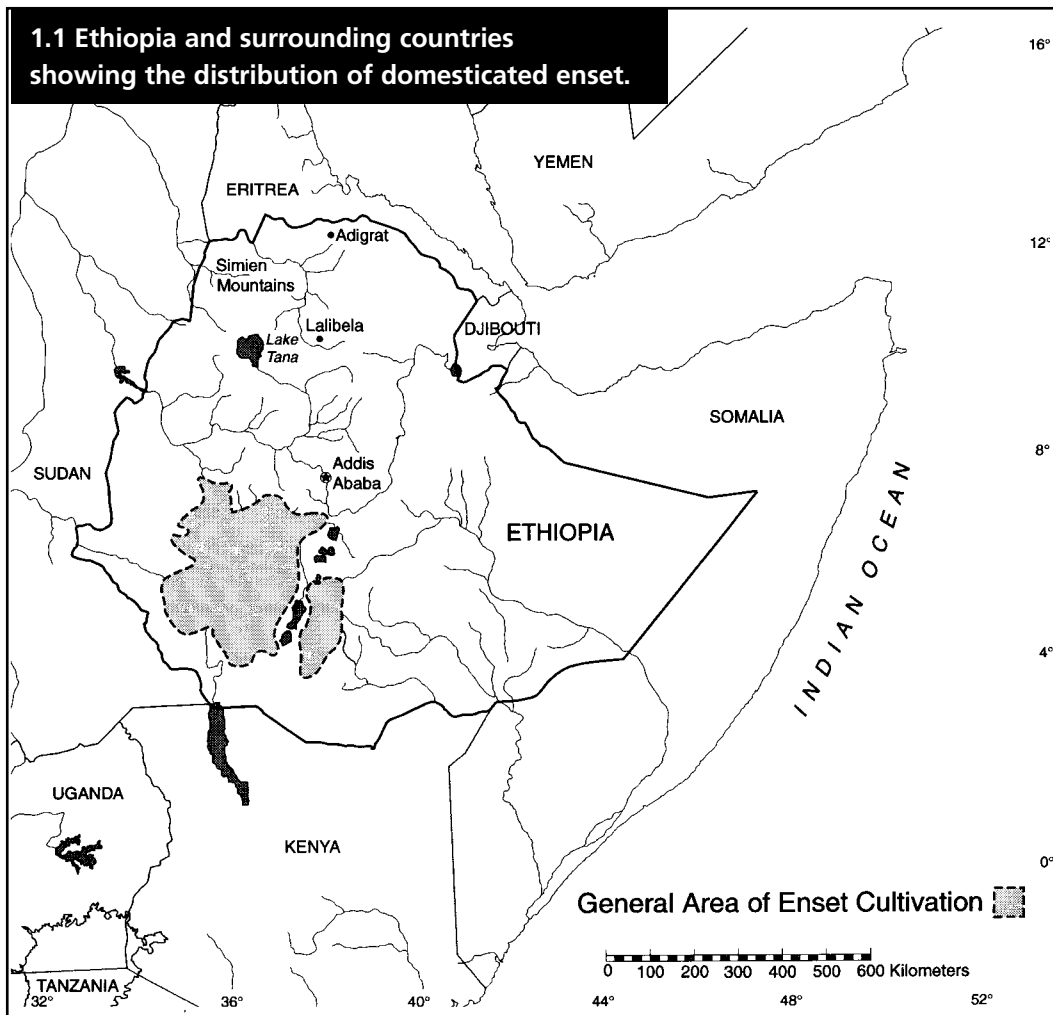
We at AAAS are delighted with this product from the symposium. It opens the door for further exploration into one of Africa's unknown food resources in a format that is clear and easy to understand. It is set up in such a way that key questions about enset are answered concisely and without technical mystification. We also refer the reader to the AAAS Sub-Saharan Africa Program web site (<http://www.aaas.org/international/ssa/ssa.htm>), where this publication will be found with each question hypertext-linked to its answer.

Peter Schmidt
Director
Sub-Saharan Africa Program

INTRODUCTION

Since Ethiopia's tragic drought and famine-prone decades of the 1970s and 1980s, researchers and policymakers have been particularly concerned with finding long-term, sustainable solutions to Ethiopia's food security needs. The majority of extension, development, and research on Ethiopian agriculture has focused upon the cereal-based systems of the highlands of northern, central, and eastern Ethiopia, and to a lesser extent upon the shifting cultivation economies of subtropical and lowland western Ethiopia. There has been considerably less research on Ethiopia's other major agricultural complex, the enset agricultural system of the highlands of southern Ethiopia.

Enset (*Ensete ventricosum*) is the main crop of a sustainable indigenous African system that ensures food security in a country that is food deficient. Enset is related to and resembles the banana plant (Plate 1, page 12) and is produced primarily for the large quantity of carbohydrate-rich food found in a false stem (pseudostem) and an underground bulb (corm). More than 20 percent of Ethiopia's population (more than 10 million people — the precise number of enset users is unknown), concentrated in the highlands of southern Ethiopia (Figure 1.1), depend upon enset for human food, fiber, animal forage, construction materials, and medicines.





INTRODUCTION

Enset agriculture has received surprisingly little extension, development, or research attention, perhaps because: 1) the majority of enset farmers live in one of the least developed regions of Ethiopia, making access and logistics difficult; 2) the system is unique when compared to cereal farming; 3) production processes are complex; and 4) there is the perception that it is eminently successful, sustainable, and trouble-free.

Since the 1950s Ethiopian and international scientists have carried out enset research, but much of this work was undertaken by isolated researchers and was often focused by discipline on specific topics and poorly funded. In the early 1990s multidisciplinary, multinational teams of agronomists and social scientists conducted pilot studies and held discussions with several Ethiopian institutions and individuals in order to determine: 1) whether a more detailed understanding of enset agriculture could contribute to Ethiopia's present and future food security needs, and, if so, how; 2) what the current status of enset extension and research was; and 3) the potential for collaborative investigations.

The general conclusion was that an integrated and comprehensive study of the biological, agricultural, ecological, social, and economic components that make up enset-based agricultural systems was greatly needed if Ethiopia was to: 1) increase production and distribution of enset products, not only within rural southern Ethiopia, but for urban markets; 2) transfer enset-based agricultural systems, or parts thereof, to other, non-enset growing regions of highland Ethiopia; and 3) determine if the sustainability of enset agriculture was under threat in the short or long term.

In order to initiate the development of such integrated and comprehensive multidisciplinary projects, the International Workshop on Enset was held in December 1993 in Addis Ababa, under the auspices of the Ethiopian Institute of Agricultural Research and the University of Florida. With over 60 participants and 32 papers presented, the purpose of the workshop was to: 1) bring together for the first time Ethiopian and other researchers from international, national, and nongovernmental organizations involved or interested in enset agriculture; 2) determine the

current state of knowledge on enset; 3) increase the Ethiopian and international public's awareness of the importance of enset-based agriculture in Ethiopia; 4) identify future avenues of enset investigation; and 5) devise a long-term, interdisciplinary plan for extension, development, and research on enset-based farming systems (Abate *et al.*, 1996).

Current research efforts in Ethiopia are largely relegated to the Southern Nations, Nationalities, and Peoples Regional Government (SNNPRG), where the Awassa Research Center and Areka Research Station are conducting various enset studies with a team of eight to ten scientists. Several researchers at Awassa College of Agriculture and Addis Ababa University also have enset-related projects. However, no specific technical packages are currently being promoted to farmers. In 1995 the Enset Needs Assessment Project was initiated as a direct outgrowth of the International Workshop. Funded by Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ), Germany, and coordinated by the SNNPRG Bureau of Agriculture in collaboration with Ethiopian and foreign institutions, the goal of the project is to provide baseline data for extension, development, research, and policy agendas for national and international institutes, individual researchers, national policymakers, and donor agencies. The first phase, comprising a literature review, rapid rural appraisal, and informal surveys of three major ethnic groups that use enset as a staple or co-staple, has been completed. Phase Two, the design and collection of household, yield, market, and processing questionnaires, and the collection of additional data from other enset-based ethnic groups, is in the process of analysis by many of the authors of this publication.

International donors have in general been reluctant to commit funds for enset research. However, in July 1997 the Ethiopian Ministry of Agriculture designated enset as a national commodity, which may pave the way for changes in research and extension programs. As these programs are formulated, more complete information on enset systems will be required. It is in this spirit that this booklet has been put together. The objectives here are to: 1) bring together and put into focus what we know and what still needs to be researched in order to document a sustainable system; 2) map out future research agendas for national and international scholars; and 3) provide information to government policymakers and donors for potential interventions to assist enset producers. This publication has been prepared in the form of questions and answers, to provide an accessible approach to the subject, and to elucidate what we know and what needs to be known for future work and interventions.

DESCRIPTION OF ENSET AND SYSTEMS

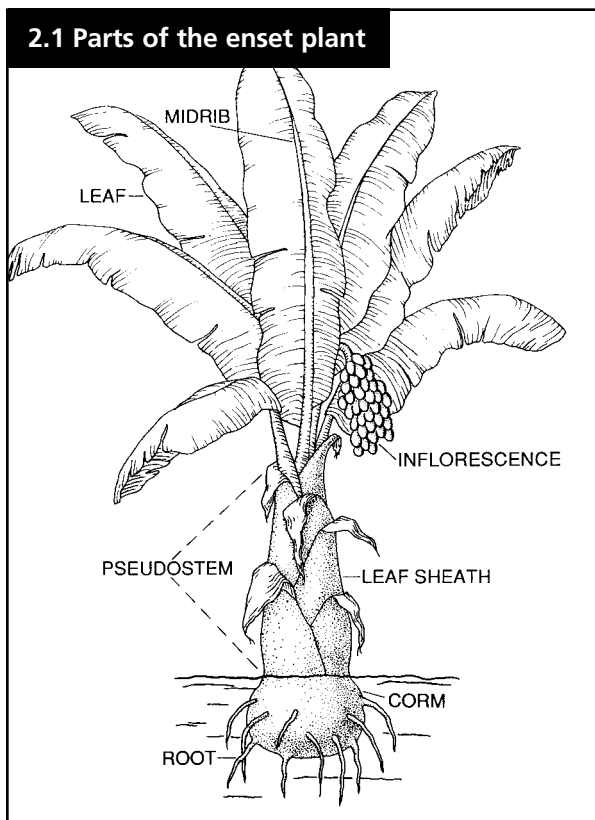
■ What does enset look like?

Enset looks like a large, thick, single-stemmed banana plant (Plate 2, page 12). Both enset and banana have an underground corm, a bundle of leaf sheaths that form the pseudostem, and large leaves (Figure 2.1). Enset, however, is usually larger than banana, with the largest plants up to 10 meters tall and with a pseudostem up to one meter in diameter. The leaves are more erect than those of a banana plant, have the shape of a lance head, and may be five meters long and nearly one meter wide. Banana plants normally form suckers or clusters of plants at the base, but enset does not.

The stem has three parts. The upper-most portion is the pseudostem, which is made of a system of tightly clasp ing leaf bases or leaf sheaths. The pseudostem may be two to three meters tall and contains an edible pulp and quality fiber. The underground corm is really an enlarged lower por-

tion of the stem. It may be up to 0.7 meters in length and in diameter. A short section of stem near the soil line, between the pseudostem and corm, is the true botanical stem. Leaves and the single flower head initiate from the true stem at its center, grow up through the middle of the pseudostem, and emerge at the whorl in the middle of the leaf bases. Enset has a fibrous rooting system that grows out from the corm.

At maturity, a single flower head emerges, which forms multiple flowers, fruit, and seeds. The entire head, which may be nearly one meter in length, hangs downward from a stalk in the center of the plant. Many of the small, banana-like fruits (enset is sometimes called false banana) on each flower head produce several irregularly shaped black seeds, each about one centimeter across. Most wild and a few cultivated plants are produced from seed, and have more than one parent. Most domesticated plants, however, are propagated from suckers, and are clones of their one parent. Most plants are harvested before or at early stages of flower formation.



■ What is the botanical classification of enset and how is it distributed?

Enset belongs to the order *Scitamineae*, the family *Musaceae*, and the genus *Ensete*. Banana is in the same family as enset, but in the genus *Musa*. Although further research still needs to be done on the taxonomy and distribution of enset species, current data reveal two wild enset species distributed over much of Asia, and four wild species in sub-Saharan Africa and Madagascar (Baker and Simmonds, 1953; Simmonds, 1958). *Ensete ventricosum*, the only known wild species in Ethiopia, is concentrated in the southern highlands, but also grows in the central and northern highlands around Lake Tana, the Simien Mountains, and as far north as Adigrat and into southern Eritrea (Simmonds, 1960 and 1965; and observation by the authors).

In spite of the extensive distribution of wild enset, it is *only* in Ethiopia that the plant has been domesticated. Wild enset propagates naturally by seed, and is restricted in Ethiopia to elevations of approximately 1,200 to 1,600 meters above sea level. However, farmers almost always propagate domesticated enset vegetatively, and recognize more than 50 different vari-



DESCRIPTION OF ENSET AND SYSTEMS

eties, clones, or landraces (Alemu and Sandford, 1996; Shigeta, 1991; Zippel, 1995). Domesticated enset (also classified taxonomically as *Ensete ventricosum*) is planted at elevations ranging from 1,100 to more than 3,000 meters, indicating the extent to which its natural distribution has been expanded artificially through domestication. Vernacular names for domesticated enset include enset (Amhara), *asat* (Gurage), *weise* (Kambata), and *wassa* (Sidama), among others.

■ What are the enset-based systems of Ethiopia?

There are four major agricultural systems in Ethiopia: pastoralism, shifting cultivation, grain-based cultivation, and enset-based cultivation (Westphal, 1975). Within the enset agricultural system, four major enset sub-systems can be recognized, based upon environmental, agronomic, and cultural criteria, as well as the extent to which people depend upon the plant as a staple crop (Westphal, 1975; observation of authors).

One such sub-system is where enset is the staple food and main crop. Such groups as the Sidama and Gurage grow enset (Figure 2.2) in dense plantations, and are highly dependent

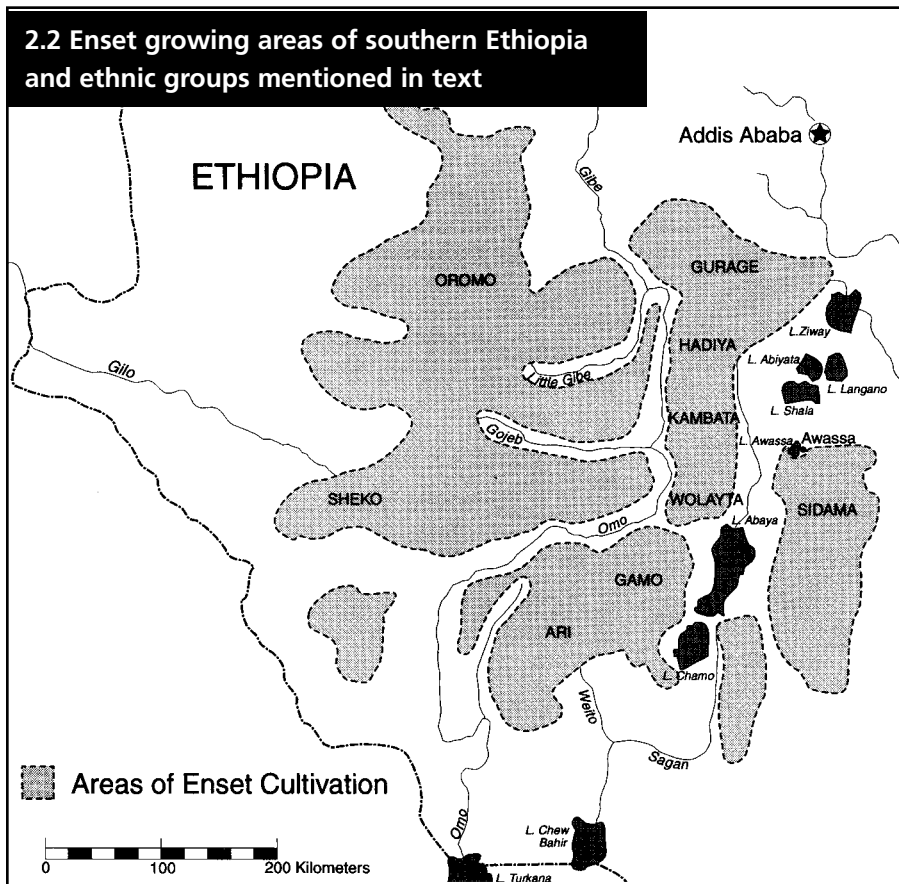
upon cattle to produce manure for fertilizing enset fields (Plate 3, page 12). The main enset product is *kocho*, a fermented bread-like food that is consumed locally as well as exported to urban markets. Population densities in these communities are commonly 200 to more than 400 persons per square kilometer.

Another enset sub-system uses enset as a co-staple with cereals and tuber crops. The Gamo, Hadiya, Wolayta, and Ari, among other groups of SNNPRG, depend upon enset as a co-staple in this manner (Plate 4, page 12). Within an ethnic group such as the Hadiya, there may be differences between households, with wealthier or higher resource households using cereals more than enset, and lower resource households being entirely dependent upon enset (Spring *et al.*, 1996). Cattle are important for manure to fertilize enset fields, while oxen are used to plow cereal fields. Both *kocho* and *amicho* (boiled enset corm) are eaten. Population density among these groups is high, sometimes with more than 200 people per square kilometer.

A third enset sub-system relies upon cereals as the most important crops, with enset and root crops of secondary importance. Such groups as the Oromo farmers of southwestern Ethiopia exemplify this system, where both the hoe and plow are used to grow cereals. Enset is grown largely for security reasons (i.e., if cereal crops fail) and eaten in the form of *kocho* and *amicho*.

Livestock are important for transport and plowing, but far less so for producing manure as enset fertilizer.

The fourth enset sub-system is where root crops are of prime dietary importance, cereals are of secondary importance, and enset is of minor importance. Groups such as the Sheko in southwestern Ethiopia practice hoe-based shifting cultivation, in which yams and taro are the most important crops, while enset, cereals, and cattle-herding are of minor importance. Traditionally, enset is processed for eating simply by cutting the corm into pieces and cooking over hot stones. Population densities are low in these groups, and settlements are small and dispersed.



ECOLOGY AND ENVIRONMENT

■ Where is enset grown and what is its range of environmental adaptation?

Domesticated enset is planted at altitudes ranging from 1,200 to 3,100 meters. However, it grows best at elevations between 2,000 and 2,750 meters. Most enset-growing areas receive annual rainfall of about 1,100 to 1,500 millimeters, the majority of which falls between March and September. The average temperature of enset growing areas is between 10 and 21 degrees centigrade, and the relative humidity is 63 to 80 percent.

Detailed studies on the effects of environmental constraints such as temperature and water availability have not been conducted on enset. Therefore, comments about the range of adaptation and the effects of environment on such characteristics as plant growth, time to maturation, yield, and pest management are from preliminary observations. Enset is not tolerant to freezing. Frost damage on upper leaves is commonly observed above 2,800 meters above sea level, and serious stunting is seen above 3,000 meters. For a certain range below 1,500 meters, the constraint to enset plant growth probably is more related to available water than to high temperatures. In most areas of Ethiopia below 1,500 meters, the total rainfall and the length of the rainy season decrease, and the potential water use by plants increases because of the greater evaporative demand. Most enset plantings below 1,500 meters have supplemental irrigation or are small enough in size that household waste water may be applied.

There has been much speculation about the drought tolerance of enset. Farmer interviews suggest that those populations dependent upon enset have never suffered from famine, even during Ethiopia's tragic drought and famine prone decades of the 1970s and 1980s. Several authors (e.g., Bayush, 1991; Shigeta, 1990) have noted that enset tolerates short season droughts that have seriously damaged annual crops, especially cereals. During the dry spell, only the edge of older leaves and the outer leafsheath are visibly affected, and the plant resumes normal growth after the onset of the rainy season.

Characterization of enset drought tolerance is a vital issue in clarifying the role of enset in Ethiopian food securi-

ty. Observed drought tolerance and its attributes must be carefully interpreted. Will enset grow and produce successfully where the average annual rainfall is less than 1,100 millimeters, or where the dry season has an average length greater than where it is currently grown? Research data are needed to answer these questions. It is hypothesized here that, once enset is established, it can tolerate occasional years of unusually low total rainfall or a short rainy season. During that stress year, enset plants may gain little additional weight, but they can survive and provide an all-important food source (which can also be stored for months and years) when there is failure of crops that produce an annual harvest. In environments where enset is adapted, enset can serve a vital role similar to that of livestock, i.e., providing food "on the hoof" for famine years. However, enset will fail in environments of consistently low rainfall or short rainy seasons.

Enset is not affected by occasional heavy rainfall. This resilience is attributed to the plant's stiff leaves, which resist large rain drops. In fact, one of the main attributes of enset is that it protects the soil from erosive rainfall. The main danger of heavy rains to enset is that roots and the corm do not tolerate water-logging for long periods. For that reason, enset is usually grown in soils that do not have high water tables and are well drained.

Enset grows well in most soil types, if they are sufficiently fertile and well drained of water. Cattle manure is used as the main organic fertilizer. Manure increases water holding so that soil water endures longer into the dry season, and reduces the negative effects of the high clay content of vertisols. The ideal soils in enset growing areas are moderately acidic to alkaline (pH 5.6 to 7.3) and contain two to three percent organic matter.



■ How does the production of enset affect the environment?

Observations in areas that have been planted with enset for many years suggest that native soils have been altered positively by the long-term application of manure. Compared to native soils that have not been similarly treated, these modified soils are likely to be more fertile and have better physical characteristics, such as water holding capacity. Enset's perennial canopy of leaves and the abundant accumulation of litter also reduce soil erosion and organic matter decomposition to a minimum. Because enset production improves soils, particularly with adequate manure, many enset fields have been in continuous production for decades, if not centuries. A current fear is that significant increases in human population and decreases in animals and manure may cause reductions in crop yields and soil fertility, thereby reducing the long-term sustainability of the enset system. Increased use of fertilizer may not com-

pensate for the manure loss because of the multiple roles that manure plays in improving soils biologically, chemically, and physically.

Enset affects the physical environment around houses where it is most commonly grown. Enset serves in the same role as trees, providing people, other plants, and animals with protection from wind and sun. Having a field that partially encompasses the homestead is considered aesthetically desirable by enset-based societies; enset beautifies the Ethiopian landscape by its thick, dark green foliage (Plate 1).

Enset is also likely to affect the macro-environment of an area in a positive manner. It has been commonly observed that species like enset, with deep roots and leaf canopies of long duration, improve the hydrological dynamics of an area, as can easily be measured at the watershed level. As the proportion of these species increases with respect to annual species, water infiltration increases and surface runoff decreases, resulting in more water in the soil and aquifers. The result is increased water availability and greater volume and duration of discharge to springs, decreasing the effective length of the dry season.

HISTORY

■ What are the origins of enset agriculture?

Given the restricted geographic distribution of domesticated enset and the degrees of complexity and variability in contemporary enset agricultural systems, agronomists and biogeographers have long considered the Ethiopian highlands to be the primary center of origin for enset agriculture (Harlan, 1969 and 1992; Sauer, 1952; Vavilov, 1951). Anthropologists, archaeologists, historians, and other scholars have also developed theories that argue for the domestication of enset in Ethiopia as early as 10,000 years ago.

Stiehler (1948), one of the first scholars to consider enset origins, believed that the indigenous hunter/gatherers of southern Ethiopia were the first to cultivate enset. He also proposed that enset agriculture was later introduced to the northern Ethiopian highlands by Cushitic-speaking peoples, only to be replaced by such crops as wheat, barley, and t'eff following the migration of Semitic-speaking groups into northern Ethiopia. In a similar vein, Murdock (1959) suggested that sometime in prehistory "Sidamo tribes" (i.e., Omotic and eastern Cushitic-speaking groups) of southwestern Ethiopia independently brought enset under domestication. Later, central Cushitic-speaking peoples of northern Ethiopia (i.e., the Agaw) also began to grow enset and a wide range of other crops, and were quick to incorporate wheat, barley, cattle, goats, and sheep into their economy once these domesticates were introduced into Ethiopia from Dynastic Egypt. Soon thereafter, cattle became important to enset farmers as a source of manure for fertilizing their fields.

Another theory proposes that Nilo-Saharan speaking farmers were forced out of the lowlands of eastern Sudan and western Ethiopia some 4,000 to 5,000 years ago because of the increasingly drier climates of the mid-Holocene (Clark, 1967 and 1976). Migrating east to the Ethiopian highlands, they introduced farming to the indigenous hunter/gatherers of highland Ethiopia and Eritrea, who began cultivating enset and other indigenous Ethiopian domesticates on their own. Drawing largely upon historical-linguistic data, Ehret (1979) proposed another theory that argues for a much earlier date for the beginnings of enset food production, perhaps as early as 10,000 years ago. He suggested that Omotic-speaking peoples, responding to a food crisis at the end of the

Pleistocene, first increased their consumption of wild enset and then eventually domesticated the plant. Sometime between 8,000 and 5,000 years ago, cattle, sheep, and goats were introduced into Ethiopia from the Sudan and were rapidly incorporated into existing enset systems.

Recognizing the need to explain how enset agriculture evolved into the diverse systems that exist today, S. Brandt (1984 and 1996; and Brandt and Fattovich, 1990) developed a model that expands upon previous theories by arguing that the arid conditions of Ethiopia during the height of the Last Glacial some 18,000 to 10,000 years ago (Gasse *et al.*, 1980) resulted in major changes in the environment and in the abundance and predictability of critical resources. The highlands of southern Ethiopia became an environmental refuge where "complex" hunter/gatherer systems emerged, which used certain wild animals and plants, including enset, as dependable, stress-relieving food resources. Between 10,000 and 5,000 years ago, enset was fully domesticated and a system of shifting cultivation emerged.

By the mid-Holocene (4,000 to 5,000 years ago), the introduction into Ethiopia of foreign domesticates such as cattle, sheep, and goats (Brandt and Carder, 1987), as well as wheat and barley, resulted in the establishment of more intensive forms of agricultural production in the highlands. These forms included the use of the plow, irrigation, and terracing, as well as the greater utilization of manure as a means to maintain the fertility of enset without having to practice shifting cultivation. Increasing population densities may have forced some societies to develop additional methods of intensification, including techniques to postpone consumption and prevent surplus crop spoilage (e.g., the fermentation and storage of enset in deep earthen pits). Over the last 3,000 years new socioeconomic and political alliances resulted in the establishment of chiefdoms and states in highland Ethiopia, dependent to various degrees upon enset food production.

■ What is the historical evidence for enset agriculture in northern Ethiopia?

Today the vast majority of enset farmers live in southern Ethiopia. However, historical evidence suggests that enset may have once played a much more important role in the agricultural practices of central and northern Ethiopia. The earliest recorded evidence of enset agriculture in northern Ethiopia is from the “Royal Chronicles”—medieval manuscripts written by priests in the liturgical Ethio-Semitic language of Geez. There is a single passage dating to 1590 mentioning Oromo peasants growing enset for food south of the Blue Nile River (Pankhurst, 1996).

European travelers of the 1600s and 1700s provide information on enset agriculture. In the early 17th century, Manuel de Almeida, a Portuguese Jesuit traveling through northern Ethiopia in the area south of Lake Tana and north of the Blue Nile, noted that enset was “the sustenance of most of the people ... The tree itself is eaten, either sliced and boiled, or crumbled and ground into meal which they put into pits in the ground where it keeps for many years ...” (Almeida, 1954). In 1640 Jeronimo Lobo, another Portuguese priest traveling in the region, described enset as “a tree peculiar to this country” which “when cooked ... resembles the flesh of the turnips, so that they have come to call this plant ‘tree of the poor’ even though wealthy people avail themselves of it as a delicacy, or ‘tree against hunger,’ since anyone who has one of these trees is not in fear of hunger” (Lockhart, 1984).

The 18th century Scottish traveler James Bruce described enset as grown in “large, thick plantations” south of Lake Tana, “exposed for sale” in local markets and as “food in great quantity” growing in “great perfection at Gondar.” Furthermore, he stated that it was “the general opinion” that enset was “naturally produced in every part of Abyssinia, provided there is heat and moisture” (Bruce, 1790). Although R. Pankhurst (1996) has questioned the accuracy of some of Bruce’s descriptions of enset, there is little doubt that enset was a significant crop in the Lake Tana region at that time.

However, by the 1840s, enset had apparently all but disappeared as a food source in the north. Charles Beke, a British traveler, provided a detailed description of farming in the Lake Tana area as a region dedicated to cereal production and consumption with little enset (Beke, 1844).

The reason(s) for the rapid demise of enset in northern Ethiopia remains unknown and unstudied. Possibilities include disease and drought. It is also possible that the dramatic socio-political events that took place in northern Ethiopia between the mid-1700s and mid-1800s played a critical role in the rapid reduction of its production. In 1769, following the collapse of the once-unified Kingdom of the Solomonic Dynasty, northern Ethiopia entered the period known as the “Era of Princes” or *Zemane Masafent*.

During this turbulent period, northern Ethiopia was racked by socio-political and economic insecurity and unrest, brought on by the rapid rise and fall of petty kingdoms, increasingly more dependent upon tax and tribute from their desperate peasantry. Kaplan (1992) states that “for the population in general and the peasants in particular, the *Zemane Masafent* was a period of severe hardship. In the best of times the lot of the peasants and in particular those who labored as tenant farmers was not a happy one. For them the endless military conflicts of the *Zemane Masafent* aggravated an already difficult situation. The soldiers of the different regional armies lived off the land, ravaging both enemy territories and those of their masters. Insecurity, poverty, and depopulation were characteristic of this period.”

The consequences of this difficult period for enset farming could have been two-fold. First, peasants may have been unable to devote the minimum two to three years necessary to re-establish enset farms and regain associated livestock during unending periods of insecurity, destruction, displacement, and depopulation. In this situation, it would have been much simpler to plant and harvest annual cereals. Second, faced with rising debts from standing armies and other war-related activities, landlords and nobility may have directly and indirectly placed considerable pressure upon the peasants to emphasize more prestigious, surplus-producing, and income-generating crops such as cereals, rather than subsistence “peasant food” like enset. A somewhat analogous situation occurred during the 1600s in the Kaffa kingdom of southern Ethiopia. Here, the desire of the royal court and elites for the “prestige” foods of t’eff and other cereals spurred them to demand cereals as tribute, since cereals “were better for tax collectors since they could be stored, divided and moved” (Orent, 1979). Whatever the causes, by the end of the 19th century when King Menelik conquered surrounding regions to create the modern map of Ethiopia, enset food production in the north was practically nonexistent.



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Unfortunately, archaeological and historical research into the origins and evolution of enset agriculture is just beginning, so specific data are lacking (Brandt, 1984 and 1996; Clark, 1988; McCann, 1994; Pankhurst, 1996; Phillipson, 1993). Therefore, the various theories scholars have constructed are untested and will remain so until long-term archaeological and historical research is initiated.

■ **What role has enset played in the agricultural policies of Ethiopia's recent and current governments?**

During Haile Selassie's reign from the 1920s to 1974, and in particular after World War II, Ethiopia's Ministry of Agriculture launched major initiatives to increase food production. Among these initiatives was the establishment of Ethiopia's first agricultural university, funded and staffed in large part by the United States. Haile Selassie's government gave explicit instructions to focus upon cereal agriculture and other income-generating crops such as coffee; enset was virtually ignored.

Following the Ethiopian Revolution of 1974, the communist-inspired military dictatorship established small research programs and experimental stations for enset, but provided little in the way of operating funds or staff. It also tried to establish Soviet-type collective farms in enset growing regions, with the usual abysmal results. After the fall of Mengistu in 1991, the current Ethiopian government has shown more interest in enset and recognized its importance to the people of the south. In 1997 the government declared enset a "national crop" worthy of significant increases in research and development funding.

USES OF ENSET

EVERY PART OF THE ENSET PLANT IS USED. FARMERS SAY THAT “ENSET IS OUR FOOD, OUR CLOTHES, OUR BEDS, OUR HOUSES, OUR CATTLE-FEED, OUR PLATES.”

■ What are the food uses of enset?

The major foods obtained from enset are *kocho*, *bullā* and *amicho*. *Kocho* is the bulk of the fermented starch obtained from the mixture of the decorticated (scraped) leafsheaths and grated corm (underground stem base). *Kocho* can be stored for long periods of time without spoiling. The quality of *kocho* depends on the age of the harvested enset plant, the type of clone (variety), and the harvesting season. Moreover, within one plant, the quality is influenced by the part of leafsheath and corm processed. The preferred type is white in color and is obtained from the innermost leafsheaths and inner part of the corm, while the lowest grade is blackish and is obtained from the outer leafsheath and corm. Although many different dishes are prepared from *kocho* (Plate 6l, page 17), a pancake-like bread is the most common. *Kocho* prepared as a fermented enset bread has also become extremely popular at restaurants that serve the Ethiopian delicacy of *kitfo* (raw ground beef mixed with butter and spices). The combination of *kocho* and *kitfo* is now virtually required at restaurants. (Plate 5c, page 13).

Bullā is obtained by: 1) scraping the leafsheath, peduncle, and grated corm into a pulp; 2) squeezing liquid containing a starch from the pulp (Plate 6f, page 16); 3) allowing the resultant starch to concentrate into a white powder; and 4) rehydrating with water. It is considered the best quality enset food and is obtained mainly from fully matured enset plants. *Bullā* can be prepared as a pancake, porridge, or dumpling.

Amicho is the boiled enset corm, usually of a younger plant (Plate 5b, page 13). Enset plants may be uprooted for preparing meals quickly if the amount of enset harvested is insufficient, or for special occasions. The corm is boiled and

consumed in a manner similar to preparation methods for other root and tuber crops. Certain clones are selected for their *amicho* production.

■ What are the non-food uses of enset?

Enset provides fiber as a byproduct of decorticating the leafsheaths. Enset fiber has excellent structure, and its strength is equivalent to the fiber of *abaca*, a world-class fiber crop. About 600 tons of enset fiber per year are sent to factories. In rural areas the fiber is used to make sacks, bags, ropes, cordage, mats, construction materials (such as tying materials that can be used in place of nails), and sieves (Plates 5g and 5h, page 14).

Fresh enset leaves are used as bread and food wrappers, serving plates, and pit liners to store *kocho* for fermentation and future use (Plate 6g, page 16). During enset harvesting enset leaves are used to line the ground where processing and fermentation take place.

The dried petioles and midribs are used as fuel, and to make mats and tying materials for house construction (Plate 5f, page 14). The dried leafsheaths are used as feed and wrapping materials. The pulp from the dried leafsheaths, petioles, and midribs is used as cleaning rags and brushes, baby cushions/diapers, and cooking pot stands. Dried leafsheaths are used as wrappers for butter, *kocho*, and other items to transport to local markets (Plate 5e, page 12). Enset leaves are an important cattle feed, especially in the dry season when grasses are scarce. Leaves are carried into the house for stall feeding of cattle during the nighttime (Plate 5d, page 13).

Particular clones (or varieties) and parts of enset plants are used medicinally for both humans and livestock to cure bone fractures, broken bones, childbirth problems (i.e., assisting to discharge the placenta), diarrhea, and birth control (as an abortifacient).



PLATES



Plate 1



Plate 2



Plate 3



Plate 4

1. Enset plants surround the house providing shade, security, and a close-by food supply.
2. Wide spacing between nearly mature enset plants in this woman farmer's field. The distance between plants is being measured by Ethiopian scientists.
3. Enset as a staple crop in Sidama. Notice that enset is grown close to the home, while cattle graze outside the enset area, which are sometimes fenced to keep them out.
4. Enset and annual cereal crops are mixed in this system of wealthier households in one area in Hadiya. Notice the planting on slopes and the hedge fencing between crops to restrict livestock.



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Plate 5a



Plate 5b



Plate 5c



Plate 5d

- 5a. A woman selling *kocho* at a local market. Note that enset leaves are used like plates or mats on which to display the product. Only woman market enset food products.
- 5b. Husband and wife selling *amicho*, the small, immature corm, at the market. The *amicho* will be boiled and eaten like a potato.
- 5c. Chef in restaurant in Addis Ababa displaying a variety of cooked foods made *bulla* (including mixtures with butter, cheese, meat, and dark greens) and *kocho* (rolled pancake bread).
- 5d. Boy feeding enset leaves to cattle.



USES OF ENSET



Plate 5e



Plate 5f



Plate 5g



Plate 5h

- 5e. Enset leaves being sold in the market. They will be used as wrappers for fresh food, as well as for cooking food on the griddle.
- 5f. Man using cordage made from dried enset petioles and midribs as construction material to build a house.
- 5g. Men selling rope at a local market made from enset fiber (gleaned from processed pseudostems). Most rope sellers and buyers are men.
- 5h. Woman at local market selling a basket sieve both made from enset fiber and used to sift *kocho* and *bulla* before cooking.



THE "TREE AGAINST HUNGER"



Plate 6a



Plate 6b



Plate 6c



Plate 6d

- 6a. Man uproots enset plant for processing.
- 6b. Woman has removed the outer leaf sheaths.
- 6c. Women pull apart the pseudostem.
- 6d. Woman decorticates pseudostem using a bamboo scraper.



USES OF ENSET



Plate 6e



Plate 6f



Plate 6g



Plate 6h

- 6e. Women pulverize corm *in situ* using serrated wooden tool.
- 6f. Squeezing starch (*bulla*) from decorticated and chopped enset.
- 6g. Woman putting decorticated and chopped enset in pit lined with enset leaves.
- 6h. Woman taking fermented *kocho* out of the pit. Note the two qualities of *kocho*. The darker, poorer quality *kocho* is from the edges of the pit.



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Plate 6i



Plate 6j



Plate 6k



Plate 6l

- 6i. Woman chopping the fibrous enset using a wooden device to protect her hands; nonetheless, women often have scars on their hands.
- 6j. "Pearling" enset to remove fibrous remnants and create a textured product before cooking.
- 6k. Shaping the *kocho* for additional chopping and fiber separation before cooking.
- 6l. Cooking *kocho* into the pancake-like flat bread on an iron griddle.



USES OF ENSET



Plate 7



Plate 8



Plate 9

7. Enset research trial at Areka Research Station. Note that thus far, there have not been any trials carried out by farmers on their own lands.
8. Man incorporating manure and preparing the land for enset cultivation using an iron pointed hoe. Notice the two stages of enset plants in the background, the smallest being one to two year old suckers, and the larger ones being three to four year old transplants.
9. Lalibela, northern Ethiopia. Enset grows in the garden of a household. Enset is not processed for food, but instead the leaves are used to wrap bread for baking.

Photo Credits

Assefa Amaldegen Plate 5d

Steven Brandt Plates 3, 5b, 5f, 9

Clifton Hiebsch Plates 5c, 6a, 6b, 6c, 6e, 6f, 6h, 6j, 8

Anita Spring Plates 1, 2, 4, 5a, 5e, 5g, 5h, 6d, 6g, 6i, 6k, 6l, 7

AGRONOMY AND PRODUCTION MANAGEMENT

■ How is enset produced?

Compared to most crops, particularly annuals, the production of enset involves many more steps. Suckers are usually produced from the two- to four-year-old corms (10 to 20 centimeters in diameter) and the true stem. (The mother corm piece may be a whole corm or some portion of it.) These mother corm pieces are obtained by harvesting healthy plants, cutting off the pseudostems, removing the roots, and cutting out the center or apical bud, from which leaves and the flower stalk develop. Because of dominance by this apical bud, lateral buds on the true stem do not usually develop; but once the apical bud is removed, these lateral buds form suckers around the periphery of the mother corm piece.

The mother corm pieces are usually planted in a nursery, often with manure, where they can receive extra care. Suckers are also formed from plants left *in situ* with the pseudostem and apical bud removed. It is common for a farmer to have 5 to 15 mother corm pieces each year. Usually from 20 to 100 suckers form per corm piece. These suckers are usually allowed to grow for one year before transplanting, although they may be transplanted sooner or even left for a second year if the farmer has excess planting material.

Suckers are transplanted using a hand hoe, usually to an area that has been well prepared with added animal manure. At and beyond this stage of sucker transplanting, there is tremendous variation in management. Plants may be transplanted only once or up to four times, at ever wider spacing. Not all plants within a farm or a field may receive the same transplanting management. Some plants may be harvested at a young age (two to three years) for *amicho* and some may later be harvested for *kocho*. This variation in transplanting and harvest management seems to be a function of ethnic group, household needs, and available resources (such as land, labor, capital, and other food crops in the system). Elevation primarily affects the number of years that plants are left at each stage, because cooler temperatures slow plant growth. By contrast, manure speeds plant growth and time to harvest.

A general objective of most enset transplant systems seems to be to maintain a leaf canopy that covers the soil for most of the year. Therefore, small plants are spaced close together, e.g., half a meter apart, and/or are intercropped with other species or larger enset plants. As increased plant size and leaf canopy allows for efficient use of a wider spacing, some or all plants in a field may be transplanted to another field. For example, there are up to three additional transplantings of all plants in the Gurage system, while in the Sidama system some plants are thinned and moved to another field. Whether taken from an area where all plants are removed or from an area where there is selective thinning, the plants may be: 1) transplanted to a uniform stand of only removed plants; 2) incorporated with plants of similar size but different ages and previous management; 3) planted in open spaces between taller (either uniformly sized or variably sized) plants; or 4) intercropped (e.g., with coffee or citrus trees).

Enset may be grown alone in uniform stands of similarly sized plants, in mixed stands of enset plants of different sizes, ages, and clones, or in a combination of these at different stages. Enset may also be intercropped with other species, in which case there is a tendency to intercrop younger enset plants with annual crops (such as maize and cabbage), and older enset plants with perennials (such as coffee and citrus). In either intercrop type, farmers recognize that the growth rate of enset is decreased. There are, however, no research data quantifying the effects of such cropping strategies on the performance of enset or other crops in the system, although some trials are underway at Areka Research Station (Plate 7). Also, there is no extension information available for a group of best management strategies.

The age of enset plants to be harvested may be uniform or variable. For example, most plants harvested by the Gurage are nearly mature (although poorer households may



have to harvest immature plants), while the Sheko tend to harvest many young plants for amicho. The Gamunya harvest plants of varying ages. Within an ethnic group, duration to harvest is affected by elevation (temperature), the age and characteristics of particular clones, the intended uses for food or cash, management (such as plant spacing and manure rates), and the wealth level of the household (addressed in more detail below under section on “Case Studies”). Farmers tend to believe that it is better to harvest plants at or near plant maturity, and that harvesting younger plants indicates an inadequate food supply or poverty. The importance of harvesting nearly mature plants is particularly stressed by male farmers, while female farmers in some of the same ethnic groups (e.g., North Omo) indicate they prefer to harvest smaller plants for better taste and ease of fermentation (Habte-Wold *et al*, 1996; Spring, 1996a; Tibebu *et al*, 1996; see also section on “Gender Issues,” below).

All research to date on the yield of enset has been with nearly mature plants, and generally has been at spacings designed to maximize yield per plant in the minimum duration. However, this is not the apparent objective of most farmers’ strategies. There are no data available to compare yield or land use when harvesting many closely spaced, younger, smaller plants versus fewer, widely spaced, older, larger plants. Studies on combinations of these and intercropping (either mixed sizes, clones of enset, or mixed species) strategies also are nonexistent. There is no extension information available on the spacing, timing, intercropping, and harvesting of enset, while for other crop species these facts are considered baseline extension information.

Ideally, farmers use cattle manure on enset (Plate 8). It is common for enset to receive available manure before other crops. In an ideal enset system, ruminant animals such as cattle, sheep, and goats graze on large areas of grassland and are then housed at night in corrals where manure is collected. This manure is then applied to enset and to a lesser extent to other crops. For many communities and individual households, however, manure is often scarce or nonexistent because inadequate grazing land or lack of resources limit animal numbers. In reality, increasing human population densities and/or the disappearance of grazing lands in poorer households lead to declining animal numbers and manure quantity per household, and in turn to decreasing enset yields.

In a few households with sufficient capital, fertilizer is beginning to be used on enset. This is particularly evident in the Sidama region, where farmers are accustomed to putting fertilizer on coffee, and have cash incomes from coffee sales. In the absence or shortage of cattle manure, some have tried inorganic fertilizer (diammonium phosphate) on enset. The results are mixed; growth is greater, but food yields do not increase correspondingly.

As available land per capita becomes more limited, the role of ruminant livestock for manure supply becomes one of the greatest threats to the future of this highly successful, sustainable, indigenous system. The potential for alternatives has not yet been researched. There are no research data available as a base to use for advising farmers on the rates of manure and inorganic fertilizer that should be applied to enset. Similarly, there is no information on the effect of soil type, environment, age and size of enset plant, harvesting management, intercropping, or any other variable on optimum rates of manure or fertilizer. Improved pasture and cut-and-carry systems to augment ruminant meat and milk production, let alone manure production, have not been implemented.

■ What are the diseases of enset?

Diseases are collectively the most severe biological problem facing enset. The damage that diseases can cause and the lack of knowledge about or implementation of preventative strategies contribute to the severity of enset plant diseases. Diseases are caused by several bacteria, nematodes, fungi, and viruses. Bacterial wilt, caused by the bacteria *Xanthomonas campestris* pv *musacearum*, is the most threatening to the enset system. Bacterial wilt attacks plants at any stage, including full maturity. When bacterial wilt, or any other cause, kills an enset plant late in its life cycle, it is a particularly serious loss. The farmer has already invested several years of land, labor, and resources into the plant’s production. In some enset-growing areas, such situations have caused farmers to abandon their enset farming and replace it with annual crops.

Enset is attacked by numerous diseases in addition to bacterial wilt. They include enset corm rot, enset sheath rot, and enset dead heart leaf rot, caused by an unknown bacterial pathogen and fungus, respectively, as well as root-knot, lesions, nematodes, and virus diseases.

The most important factors responsible for spreading disease of bacterial wilt include disease-infected planting mate-



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rial, contaminated farming and processing tools, and human and animal vectors. The only research-recommended control measures for diseases are cultural measures to prevent the movement of the causal agent. For bacterial wilt, these measures include the use of healthy, disease-free suckers for planting material; destruction and controlled movement of diseased plants; cleaning of equipment that has come in contact with diseased plant material; and rotation of crops. The specific practices required for realization of these control measures can require sizable investment of additional care and labor. If a farmer is not knowledgeable about the cause of disease, is not convinced that the additional effort will make a difference, or has insufficient labor, the control practices are not likely to be adopted. While there is still much to research about enset diseases, adoption of known preventions could be part of an extension campaign. However, the current lack of extension programs presents the main limitation to disease management.

Bacterial wilt is easily spread by any object touching the contaminated parts of the plant or processed enset (i.e., *kocho*). Contaminated cutting and processing tools, in particular, spread the disease. Cutting enset leaves for animal feed and wrappers may spread the disease from one plant to another. It is also postulated that mole rats, which burrow underground, can cause contamination as they tunnel from one plant to another. Similarly, snakes and insects going between plants, as well as the presence of cattle walking through fields, could also contribute to the spread of bacterial wilt. All of these transmission agents need to be researched.

In the case study areas (described in more detail below), virtually all enset fields of Gurage households are infected by bacterial wilt, while about half of the Hadiya households have infected enset fields. By contrast, the majority of Sidama households report no enset diseases on their farms, although a few households report wilt in the older enset plants. Farmers mention that bacterial wilt is more severe at high altitudes, but more research is needed to confirm this. The reason for these differences is probably related to farmers' knowledge of the methods of disease spread and contamination of tools.

Typical bacterial wilt symptoms in enset plants above two years old is that the innermost leaf sheaths become yellowish and droop. Usually only older plants are attacked; however, in one area studied the disease was observed attacking younger enset plants (even the one-year-old suckers).

The control measures used by farmers are inadequate, and seem to facilitate the distribution of the disease. In areas of greatest infestation, farmers loan or borrow farming and processing tools. Therefore both men and women engaged in cultivating, processing, and cutting leaves spread the disease.

Some households control bacterial wilt by uprooting and discarding infected enset plants as a cultural control measure; however, few households use sanitation methods for their tools. Too frequently, infected enset plants are disposed of near the enset farm, and, as such, they may be a potential source of the disease inoculum and its re-spread. Some farmers follow the enset field and practice rotation with annual crops. By contrast, in the area that is relatively free of bacterial wilt, farmers practice control measures such as uprooting the infected bacterial wilt enset plants and keeping them away from the household, other enset plants, and cattle. Farmers also try to keep healthy plants away from contaminated farm and processing tools.

Some households decorticate and process infected enset plants at their early stage of infection. Some women separate the *kocho* from infected plants (*bullu* is never made from infected plants) from the *kocho* of healthy plants by putting them in separate pits. The wealthier households have the choice of utilizing diseased plants or not. They may choose to process this lower quality *kocho* separately and sell it. The poor have less choice and may use it for home consumption, purchase it, or receive it from more affluent households as payment for their labor or craft product.

Farmers note that certain enset clones have relatively high tolerance against bacterial wilt and that particular clones revive after infection has occurred, while other clones of similar age group are wiped out by the disease.

Many Gurage farmers report disease problems related to *kocho* stored in pits, especially for an extended period of time. A tooth-shaped fungal mycelial growth (species not identified) on the upper surface of stored *kocho* in the pit is reported. The disease starts around the wall of the pit, causes a bad smell, and the *kocho* becomes highly compacted because of dehydration. Farmers report that this problem is common in *kocho* stored for extended periods of time and is easily transmitted from the nearby infected enset storage pits or pit lining materials. Farmers try to control this problem by regularly aerating the *kocho* and changing the pit.



■ What mammals and insects attack enset?

Porcupine, mole rat, and wild pig attack enset plants in the field. They usually damage the plant by feeding on the corm and pseudostem. Among these pests, the mole rat ranks number one. Since these animals are not microscopic like the bacterial and viral diseases, farmers are knowledgeable about them, and many employ effective management practices. These practices include woven fences and ditches around enset fields, to retard the movement of animals into the field, and traps for catching them. Wealthier farmers use steel traps to snare wild pigs and monkeys, and others traps for porcupines and mole rats. Burning coals may be dumped into the rat tunnels. Farmers also protect against porcupines by digging pits around enset plants so that it is difficult for the animals to get in or to climb up and get away. In some areas, farmers organize themselves on a village basis to hunt wild pests with sticks, spears, and machetes.

Insects have been considered a minor problem in enset cultivation. However, over the last several growing seasons, mealy bugs have been identified as a serious problem in cer-

tain regions. Mealy bugs are soft-bodied insects that feed on the corm and roots. Enset plants infected by mealy bugs show stunted growth; the damage appears more severe during the dry season. Because they live underground, their damage often goes unnoticed until serious loss has occurred. As they are slow moving insects, mealy bugs are controlled with methods similar to those used against diseases such as bacterial wilt.

■ What effect do weeds have on enset?

Weeds can cause greatly reduced plant growth while enset plants are small, i.e., during the sucker stage and for one or two years after the first transplant. The total land area used for production during these stages is usually relatively small compared to the farm size, and therefore weeding can be accomplished with available labor. As the enset plants become larger, the perennial leaf canopy and leaf litter on the soil surface prevent most weed growth. In annual crop production, the labor available for weed control can be a serious restriction to production. Although labor data are not available, there is probably much less labor required for weed control per ton of food in enset than on any annual crop. The reduction in labor for weed control may be offset in part by the additional labor required during harvesting and processing of enset.

HARVESTING AND PROCESSING

■ How is enset harvested and processed?

Although enset is usually harvested just before flowering, the preferred harvesting time is just when the plant flowers. The time duration required to flower depends upon climatic conditions, clone type, and management. Hence, the flowering time varies from 3 to 15 years but is optimally around 6 or 7 years. Enset processing is carried out by women using traditional tools (Plate 6), and the process is laborious, tiresome, and unhygienic. The processing is done totally by women in most ethnic groups; however, men occasionally assist women, as among the Gamo (Plate 6a).

At harvest, leaves and older leaf sheaths are first removed from the designated plants. The internal leaf sheaths (commonly up to two meters in length) are separated from the pseudostem down to the true stem, which is about a 20 centimeter section between corm and pseudostem (Plate 6c). Then the true stem is separated or stumped from the underground corm. The concave side of the leaf sheath is peeled and cut into pieces of about one meter length and split lengthwise in order to shorten the leafsheath to a workable size. Then the leafsheath is decorticated using a locally made bamboo scraper while the leafsheath is held on an incline (at 45 to 80 degrees from the ground) against a wooden plank (Plate 6d). In some groups, women may sit on the ground (often on enset leaves) and use one leg to hold the leafsheaths in place, while in other areas they bind the sheath to the board and stand to decorticate. The working area used for decortication is covered with enset leaves. There is variation in tools used (bamboo versus newly adopted metal scrapers).

There is also variation in the way that the corm is grated (Plate 6e). One practice is to uproot the corm and remove any soil from its surface. Then the corm is grated separately with a locally made wooden tool with a sharp serrated edge. Another method is to grate the corm from the inside out while still *in situ* in the ground.

After the completion of decortication and grating, the leafsheath pulp is spread on fresh enset leaves covering the ground, after which the grated corm is spread on the processed pulp. In some ethnic groups (e.g., Hadiya and Sidama) a starter is added to aid in fermentation. This starter consists of already fermented *kocho* to which various spices and herbs are added. In other localities (e.g., Gurage), fermenting agents are prepared from the inner portion of the corm and then mixed with the decorticated pulp and grated corm after some weeks. Turning, mixing, rinsing, and chopping continue over a period of time until the mixture partially ferments, when it is then referred to as *kocho* (Plate 6h-6l). The total time period for this fermentation to occur ranges from 15 to 20 days. Then the fermented *kocho* is stored in pits that are lined with enset leaves (Plate 6g and 6h). Pits vary in terms of size and depth, with some requiring ladders. The *kocho* must be left in a storage pit for a minimum of a month, but it can be stored for many months and even for several years. Some women note that for long-term storage, the *kocho* should be removed, the pit lining changed, and then the *kocho* returned to the pit.

LIVESTOCK

■ Why are livestock important in enset systems?

Regardless of elevation, ethnic group, or degree of dependence on enset in dietary intake, it appears that livestock play a critical role in maintaining soil fertility (and thus agricultural sustainability). Livestock therefore play a critical role in enset farming systems, as they provide: 1) manure for important plant crops, including enset; 2) food, especially milk and occasionally meat for the family; 3) traction for plowing; and 4) a source of wealth that can be sold to provide cash in times of need. Additionally, in ethnic groups that use equines for transportation and hauling, bundles of enset are transported to local markets. Livestock are also kept as an indicators of wealth and sources of prestige among rural cultivators.

Manure is generally applied to crops grown in the vicinity of the household, especially to those considered especially important. Enset and coffee, where grown, are almost always given priority in this regard. Enset plants may take twice as long to mature without manure as they do with the application of manure (McCabe and Lee, 1996). This view is further supported by a recent survey, which shows that “adequate farm manure is regarded as essential to successful enset growing, and . . . farmers with unproductive looking enset plantations were those farmers who have the fewest livestock” (Alemu and Sandford, 1991).

In systems where enset is mixed or secondary to cereals, oxen are critical resources in the preparation and plowing of fields for planting wheat, barley, t’eff, and other cereals. Among farmers in the enset growing region, important livestock uses do not appear to include slaughtering to provide meat for the household. However, the consumption of milk, butter, and cottage cheese seems to make an important and possibly critical contribution to an enset-based diet, which in itself is very low in protein (Shank and Ertiro, 1996; Pijls *et al.*, 1994).

Livestock throughout the rural regions of Africa and Ethiopia act as a store of wealth for a family or household, and this is certainly true for enset cultivators. Households depend on livestock as emergency resources for such things as hospital fees, and they try to save livestock for large purchases such as construction materials to build a new house.

The sale of milk and milk products can also make significant contributions to household income. It appears that until relatively recently, milk and milk products (such as butter and cottage cheese) were reserved almost exclusively for home consumption. However, during the past three decades, the sale of these products has increased, and in some cases has provided as much as 45 percent of annual household income (Beneye, 1994).

■ How are livestock managed among enset farmers?

There are common themes in the management of livestock among the peoples who cultivate enset, although regional and ethnic differences occur. Differences in management practice may be found in the different ecological zones: *dega* (highlands), *weinadega* (mid elevation), and *kolla* (lowlands). There is also variation according to wealth category, with the wealthier households possessing more livestock and requiring greater access to additional labor and grazing lands.

The management of livestock involves both taking animals to pasture and bringing forage to livestock. Individuals with one or two cattle will normally tether their animals in the grassy area in the front or side of the homestead. Those with more livestock will both tether their animals near the house and take their animals to common grazing areas, if they are available. In many villages, swampy or steep areas are set aside for common grazing (“the commons”). Those who are wealthy utilize the methods previously mentioned, but also may take their livestock for periods of time to second homesteads where the grazing resources are more abundant. Usually these second homesteads are in the lowlands, but in areas of uniformly high elevation they may be above the elevation preferred for crop production. Access to the common grazing areas is usually determined by farmers’



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proximity to the commons. However, the use of the commons appears to be changing, as more common grazing land is being turned into land that is cultivated.

Stall feeding is the principal means by which livestock are fed during the dry season throughout the enset growing areas, and is a labor intensive activity. Following harvest, crop residues are given to the livestock, and among all enset growing groups, enset leaves form an important part of the dry season livestock diet. Grass may be purchased, but it is more often cut by women from homestead pastures or common grazing areas. Cut enset leaves also contribute to livestock diets in all areas where enset is grown, and they may be used for as long as seven to eight months, or only for a couple of months at the height of the dry season, depending on area and ethnic group. Adebo (1992) reports that in one region during the early and middle dry season, women cut grasses from the village area, but when these resources were used up they had to walk to the lowlands to cut forage for their livestock. This task entailed a seven to ten hour round trip.

■ What are the major constraints to livestock production?

Cows kept by rural farmers in the enset growing area produce low quantities of milk. Estimates range from a low of approximately 0.25 liters per day to a high of about two liters per day during their seven month long lactation period. The amount of milk produced increases during the wet season, as forage resources are more abundant and calves tend to be dropped during this time. Low animal fertility is also characteristic of the livestock kept by enset cultivators. Mortality rates are high and enset cultivators typically buy and sell livestock frequently.

Low productivity and high rates of mortality and turnover strongly suggest that the livestock production system is under significant stress. Current data indicate that the most severe constraint is lack of adequate forage. A decrease in the amount of land allocated for grazing per village, and the transformation of some common grazing land to crop production have contributed to this decline in forage resources.

■ How has the system of livestock management changed over the last few decades?

Although it is typical for farmers throughout the world to remember the past as a time of plenty in contrast to the troubles of the present, the consistency of accounts in which farmers kept far more livestock in the past than they do now is striking. Preliminary research strongly suggests that there has been a serious decline in the numbers of livestock held by farmers on a household basis. What data are available suggest that a typical household kept seven to eight head of cattle, a number of small stock, and possibly a horse or two during Haile Selassie's time, while now the average household keeps two to three cattle, and maybe two or three sheep or goats.

This negative downward cycle is a result of increased demands for cultivated land as a result of increasing population pressure. Changes in the system of land tenure also contribute to this trend. The Sidama material provides a good example. Historically, during the feudalist period (1893-1935 and 1941-1974), Amhara lords left the management of the land to the Sidama people, provided that sufficient taxes were paid. Sidama elders then regulated and partitioned off areas of land for grazing. This was also a time when several families would band together and take turns spending up to a year in the lowlands with their cattle. During this period, it was typical for a village to allocate 30 percent of the land to crop production and 50 percent for grazing.

During the recent socialist period (1974-1991), farmland was divided and parceled out. In the Derg period, village land was reallocated so that 50 percent of the land was for crop production and 30 percent of the land for grazing. Areas that once were forests or grazing lands became farms. The only land not parceled out was swamp land (*chaffa*). These periodically flooded areas are now left for grazing (McCabe and Lee, 1996).

Although people describe the grass in swamplands as tough and poor for grazing, the maintenance of the swamps as grazing land is, as one man put it, "worth fighting for." Unless a farmer owns land in other areas, the *chaffas* near one's farm and one's own yard are the only sources of grazing. For example, the two swamplands in one area of Sidama were four and five hectares, respectively. Twenty percent of households in one region have second farms, mostly in order to have access to additional swamplands and other grazing areas (McCabe and Lee, 1996).



■ **Will the decrease in livestock numbers and fertility threaten the sustainability of the enset cultivation system?**

All the above factors contribute to the progressive downward spiral in the livestock production sector of the rural economy. There may be a decline in total livestock numbers in general, but there is a definite decline for individual households because of increasing population and limited land. This decline will have an impact on manure production and the availability of draught animals. It could also have an impact on human nutrition. The cycle of increasing impoverishment of the livestock component in this mixed crop/livestock system is a serious cause for concern. The multiple purposes of livestock cannot be replaced by fertilizers, and the sustainability of the enset cultivation system is a result of the tight articulation of the crop and livestock production systems.

For example, in the Sidama zone the reduction of common grazing lands has forced farmers to tether their animals in their front yards. Here, most households retain only a few cattle, while the number of donkeys and small stock has been greatly reduced as compared to the past. With an increasing population in an already densely populated area, it is likely that the negative trend in livestock populations will continue, with potentially severe impacts on enset production.

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■ Why is it important to consider gender roles and the contribution of women?

Gender roles (in terms of the division of labor for all aspects of enset production and marketing) are of critical importance (Woldetensaye *et al*, 1997; Spring *et al*, 1996). Without women to process enset, there would be no food produced and it would simply be an ornamental plant, as it is in other parts of Africa and Asia. But women's work is often relegated to lesser significance than men's. Both researchers and farmers often believe that women are involved "only" in processing and cooking of the enset, and rank these tasks below cultivation tasks. Women, in fact, do participate (in some areas and in some households) in production activities (e.g., manuring and varietal selection), and in households where there are no women knowledgeable about enset clones and processing, enset is not eaten unless others are paid to process and cook it.

Women in wealthy households became labor managers by hiring poor women to process and poor men to cultivate. Women in middle income and poor households exchange labor for processing. Men are believed to be banned from enset processing areas, but were observed helping among the Gurage. Locally, women market small amounts of *kocho*, *bulla*, and *amicho* to obtain money for household consumables (e.g., kerosene and salt). They strategize as to the amount of surplus *kocho* and *bulla* they can sell off and still have enough for the household. Both sexes sell non-food enset products (e.g., leaves, mats, rope, and other construction materials). Men keep cash from the sales of cash crops. By contrast, little is known about the ownership or remuneration received from the bundles or "jumps" of enset sold

for the market in Addis Ababa. Do wealthier women have surpluses to sell? Do wealthier men plant extra gardens and hire labor to process the plants? Is there joint decisionmaking and profit-sharing between the sexes on planting and processing? Additional research on marketing, both locally and in urban areas, is required.

■ Are there gender issues in clonal variation, in both selection and usage?

Habte-Wold *et al* (1996) argue that women farmers know a great deal about the different varieties of enset, and that "when men and women of the same household were interviewed together, women tended to dominate discussion about varieties, contrasting and comparing them and saying what should be harvested at different ages. Men played a greater role in discussing the cause of 'drop-out' other than harvesting . . . men . . . stressed the desirability of harvesting at maturity and . . . the varieties which are normally harvested later, whereas women were more concerned with a balance of varieties which can be harvested at different ages."

In addition to the gender division of labor, there are gender issues concerning varieties selected for planting and time of harvesting. Both women and men farmers categorize the varieties of enset into two categories, each with different characteristics, and they distinguish each clone in terms of its "maleness" or "femaleness" (Habte-Wold *et al*, 1996; Alemu and Sandford, 1996; Spring, 1996a; Tibebe *et al*, 1993). This categorization has nothing to do with the biological or reproductive parts of the plant, but with a set of qualities and characteristics related to desirability, time of harvesting, fiber and food content, softness and hardness, palatability, length of fermentation period, size, growth rates, and resistance to disease and pests. The so-called "male clones" mature later, and are harder but give a larger yield, while the "female clones" mature earlier, are softer, less fibrous, and more delicious. Men have a preference for the "male" enset, because they say "there is less temptation for



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the women to harvest the plant before maturity for the sake of eating the delicious boiled corm,” (*amicho*) as in the case of “female” plants (Alemu and Sandford, 1991). However, in some regions farmers do plant more “female” than “male” plants. Whether or not there are gender-specific reasons for these choices or if women manage to prevail in their own preferences needs to be investigated.

As a result, farmers, depending on their own circumstances (in terms of location, land holding size, and wealth),

strategize and maintain different numbers of clones by “sex” and age, with a slight preference for the “female” plants. Data from Habte-Wold *et al* (1996) show that farmers tend to plant a ratio of 56:44 “female” to “male” plants. Absence of men from the homestead to engage in off-farm work is believed to restrict varietal diversification, but the reasons for this, and why the wealthier have greater clonal diversification, are still unclear and require further research. In terms of such research, there is often a tendency for researchers to focus on yield as *the* major criterion, while other variables may be of greater concern and factored into varietal selection by the farmers themselves.

ENSET FARMING SYSTEMS: THREE CASE STUDIES

■ What are “enset farming systems”?

In contrast to agricultural systems that describe the predominant crop and livestock mixtures, the term “farming system” is technically determined inductively based on a configuration of agro-economical zones and cultural practices in relation to agricultural activities, farm enterprises (e.g., crops, livestock, agroforestry), and off-farm/non-farm enterprises (e.g., wage labor, crafts and trade skills, business enterprises) (Spring, 1995a; 1995b). Within the enset systems, variations in production, distribution, the types of farm and off-farm enterprises, and farmers’ management practices of enset cultivation can be described and analyzed at the household and group level. Other variations occur in planting (spacing and timing), fertilization (manuring and mulching), indigenous disease and pest control, nursery and transplanting techniques and timing, sucker propagation, harvesting and processing techniques, labor patterns, and marketing practices.

In order to study the enset farming systems and their variation at the ethnic group and household level, a number of surveys and studies have been carried out. In terms of investigations of the farming systems, diagnostic surveys using rapid rural appraisals (RRAs) have been carried out by several groups of researchers. In several regions FARM Africa has assessed the diversity of farmers, farming systems, farmers’ constraints, and potential solutions and research activities. Several surveys are specifically on enset (Alemu and Sandford, 1991 and 1996; Bull *et al*, 1995), while Zippel and Alemu (1995) present a field guide to enset clones for North Omo. Other publications on enset clones and their

gender characteristics are Alemu and Sandford (1996); Habte-Wolde *et al* (1996); and Sandford and Kassa (1994); also see Abate *et al* (1996). Informal surveys on enset have been carried out by the Institute of Agricultural Research (Raya *et al*, 1988; Degu and Workayehu, 1990; Shiferaw Tesfaye and Bizauyehu Haile, 1995), and more recently by the Bureau of Agriculture, SNNPRG (Spring *et al*, 1996). The following case studies of the Gurage, Hadiya, and Sidama zones provide some examples of the variation in enset farming systems at the ethnic group and household levels.

One peasant association (PA) in each zone was carefully selected to include altitudinal variation (low, mid, and high), accessibility, significant enset production, and cooperation of leaders and farmers. A rapid rural appraisal and additional studies of 60 households were then carried out in the three zones. The Gurage and Sidama have an enset-dominated system with variation caused by differential resource levels among households. The Hadiya, by contrast, have two different systems: one in which enset is dominant and one in which cereal crops are dominant and enset is secondary. The major cash crops in the areas studied are coffee for the Sidama, chat (a stimulant) for the Gurage, and cereals and eucalyptus tree for the Hadiya.



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Figure 10.1 Wealth Ranking by Community Leaders, Yeferezeze PA, Gurage

Wealth Category	Wealth Indicators	%
Degene (Rich)	<ul style="list-style-type: none"> • 10 or more cattle, may give some for share-raising to poor people • Self-sufficient in clothes, school fees, food • May use contract land in addition to own holdings • Harvests up to 100 enset plants/year • Owns 3 houses • Hires labor during planting, weeding, and processing of enset • Sells up to 1000 birr of chat • Harvests up to 500 kg of coffee • Owns about 3000 eucalyptus trees 	15
Gibtose (Middle)	<ul style="list-style-type: none"> • About 5 cattle (no share-giving) • Self sufficient in food, clothing, schooling • May harvest up to 50 enset plants/year • Owns two houses 	35
Zega (Poor)	<ul style="list-style-type: none"> • No cattle but share-raising them • Sells his/her labor • Harvests up to 10 enset plants/year • Sells hay from own land as an alternative source of income • Own one house 	35
Gurmasa (Poorest of poor)	<ul style="list-style-type: none"> • Livelihood depends on others for payment in cash or kind for labor & food • May share-raise cattle for milk and manure • Harvests less than 10 enset plants/year • Very small plots of land • Owns a very small house 	15

Source: adapted from Spring et al. 1996.

■ What was found in the Gurage Case Study?

The Gurage identify themselves as “people of enset” (Shack, 1966), and are one of the ethnic groups that depend upon enset as their main staple. During group focus sessions, community leaders identified four wealth or resource categories (rich, middle, poor, and poorest of the poor) based on the amount of livestock, enset plants, cash crops, and houses owned (Figure 10.1). All Gurage in the PA studied have an enset-dominated farming system, although there are differences between wealthier and poorer households in terms of the types and amounts of cash crops and enset, and the management of enset (Figures 10.2 and 10.3). Wealthy households grow large quantities of chat and some coffee for

Figure 10.2 Gurage (Yeferezeze PA) Enset Farming System

1. Cropping System	land allocation	enset > all other crops (chat for cash; no cereals)
	enset plantation size	larger for wealthy; small for poor
2. Enset System	general management	wide spacing, especially in last transplant
	clones	wealthy have many more than poor
3. Livestock	types	mostly dairy cows
	use of livestock	income source, manure, milk and meat
4. Manure	amount	wealthy have adequate, poor have inadequate
	use	on enset plus other crops
5. Processing	frequency	wealthy process less frequently than poor
	matured plants used	wealthy process more plants than poor
	storage period	wealthy store for longer, poor store for shorter
	labor for processing	wealthy hire labor, poor exchange labor (FHH have labor constraints)
	starter/pit	no starter; initially laid flat
6. Non-Farm Activities	wealthy	few
	poor	off-farm activity .e.g., crafts, selling labor
7. Diet	contribution to diet	enset is main crop
	food availability	high for all groups, period unavailable is short
8. Sales/Income	sales	enset, chat
	income	wealthy have good income plus savings

cash, while poor households mostly produce craft items (such as baskets and pottery) to earn income. Gurage farmers, who have surplus enset and live near transportation corridors, send bundles of *kocho* and *bulla* to Addis Ababa for sales to urbanites.

Houses are grouped close together, and cattle are the main type of livestock and are grazed communally as well as in side-yards. Non-food enset products such as mats, bas-



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Figure 10.3 Gurage (Yeferezeze PA) Enset Management Practices Form a Continuum on Many Variables

1. Clones	Diversity	less diversified	more diversified
2. Transplanting	Nursery time	3 years	4 years
3. Planting Method	structured row planting	used by all households	
4. Plant Density	spacing	wide used by all households (4 m by 4 m)	
5. Weeding/Cultivation	weeding	less well	well
6. Manuring/Fertilization	application methods	all households use ring and broadcast	
	season of application	fixed year round	
7. Leaf Removal	number removed	few	many (severe)
8. Intercropping	intercropping	none	some
9. Diseases and Pests	bacteria wilt	serious in all households	
	sanitary measures	little	some
	fencing	absent	present

Figure 10.4 Clones by Wealth Category, Yeferezeze PA, Gurage (in percent)

Clone Name	Rich	Middle	Poor/Poorest	Mean
1. Yeshirakinke	75	86	100	87
2. Ameratiye	100	57	43	67
3. Yekesiwe	100	86	71	86
4. Astara	100	43		48
5. Gurarge	100	57	29	62
6. Agadie	25	57		27
7. Badediet	25	14		13
8. Lemat	75	14		30
9. Kanchiwe	50	29		26
10. Kibinar	50	29		26
11. Siniwet	25			8
12. Separea		29	29	19
13. Yegendiye	25			8
14. Yireqiye	25	14		13
15. Nechwe	100	71	86	86
16. Ankefrye	25	14		13
17. Charkima	25			8
18. Oret	25	14		13
19. Gimbua		14		5
20. Deriye	25			8
21. Toshet	25			8

Source: adapted from Spring et al. 1996.

kets (made by women and girls), and construction materials (made by men) are ubiquitous. Because of enset, food availability is high even for the poorest of the poor, although the poor lack dietary diversity. A major difference between households is cattle; wealthier households have large herds, while poor households have none and have to "share-raise" calves by borrowing an animal and returning products, offspring, or the animal itself.

Unique to Gurage, compared with the other ethnic groups, is planting enset in strict rows with wide spacing, up to four meters apart in each direction (Figure 10.3). Other differences are that cattle owners have more manure to apply and do so frequently; some farmers fence their properties; and more conscientious farmers weed more fre-

quently. The frequency of transplanting and weeding have more to do with farming skills and labor availability than with wealth. Considering clonal variation, the wealthy have many more clones or varieties of enset plants than the middle and poor/very poor households (Figure 10.4).

In the study area, bacterial wilt is endemic regardless of resource level, unlike the Hadiya and Sidama areas (see below), and farmers are *not* knowledgeable about prevention measures. Further, the sale of entire fields of chat, the major cash crop, to Addis Ababa merchants may contribute to the spread of the disease, since these merchants cut enset leaves to wrap chat, perhaps using contaminated knives.

A starter is not used for fermentation (unlike in Hadiya and Sidama), but enset is laid on the ground to begin the



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process. *Kocho* is kept for long periods, with pits being changed periodically. A fungus affects long stored *kocho*. Figure 10.5 shows that rich households process many mature plants less often and their storage period is longer than poor households. The latter process small quantities more frequently, use immature plants, and quickly consume their stored *kocho*. Wealthier households hire labor for processing, while the poor exchange labor. Unlike some other groups, Gurage men help women in certain aspects of processing, and it is not “taboo” for men to be present during enset processing.

Female-headed households face labor constraints in many aspects of enset production, and are more likely to be poor. Both female-headed households and male-headed poor households are often involved in off-farm activity (e.g., crafts, selling labor), and their diets are less varied.

■ What was found in the Hadiya Case Study?

The Hadiya (Figure 2.2) grow enset in a system with cereals (wheat and barley). Wealthier farmers grow and consume more cereals than enset, while poorer ones lease bits of unused land and sell their labor for cereal production, but eat mostly enset products themselves. As a result, there are two systems, termed here Hadiya 1 and Hadiya 2. In the former, cereals predominate over enset, while the latter is completely enset-based. Wealth and livestock ownership are highly correlated (Figure 10.6), and community leaders divide their residents into wealth categories based on livestock ownership, size of the enset holdings, cash and cash crops, and housing. Ironically, they do not mention land holdings as a criterion. Land size is larger than in the other areas studied; wealthy Hadiya have much more land, as well as larger enset fields, than poor Hadiya households. Also, cultivation of annual crops and eucalyptus trees seem to contribute to soil erosion.

Figure 10.5 Number of Plants Processed and Length of Storage by Wealth Category, Yeferezye PA, Gurage

Wealth Category	Processing			Storage		
	Total Plants	Nov. to Jan.	Aug	<1 year	1 to 2 years	>2 years
Rich						
Mean	73	61	12	50%	25%	25%
Middle						
Mean	35	30	5	75%	25%	
Poor						
Mean	20	17	3	100%		

Source: adapted from Spring et al. 1996.

Figure 10.6 Wealth Ranking by Community Leaders, Ana Lemo PA, Hadiya

Wealth Category	Wealth Indicators	%
Godancho (Rich)	<ul style="list-style-type: none"> • 1 horse and mule • 1 donkey • Pair of oxen • 2 to 3 cows • 5 to 10 sheep • Minimum cash 2000 birr • 3 timad enset plantation • About 10 flowered enset plants in the field • Sell cereal crops and pulses • Lends money on credit • 2 to 4 houses, 1 large and the others small • May have more than 1 wife • Produces wheat, barley, beans, and pea by contracting land with the poor 	8
Lembeancho (Middle)	<ul style="list-style-type: none"> • 1 equine • 1 ox • 1 to 2 cows • 1 to 3 sheep • Minimum cash 1000 birr • 2 timad enset plantation • 1 large and 1 small house • 4 to 5 flowered enset plants in field • Produces wheat and barley 	50
Buticho (Poor)	<ul style="list-style-type: none"> • 1 sheep, cow, or calf • No oxen • No large enset plants in field • Usually leases land to the rich • Sells labor to the rich 	42

Source: adapted from Spring et al. 1996.



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Figure 10.7 Enset Farming Systems Types, Ana Lemo PA, Hadiya

	HADIYA SYSTEM 1	HADIYA SYSTEM 2
1. Cropping System		
land allocation	cereals > enset	enset > cereals (sharecropped)
enset plantation size	large	small
2. Enset System		
general management	good	poor
enset propagation	clones—own fields	get suckers as gifts
clone diversity	high	low
3. Livestock		
types	2 to 4 oxen	no oxen
dairy cows		none, acquire calves by loan
equines	no equines	
use of livestock	income source	none
	manure	manure, but less
	milk and meat	milk, but less
	draft power	none
	transport	none
4. Manure use		
	available	little manure
	enset and crops	mostly for enset
5. Processing		
frequency	low (2/yr.)	higher (3 to 5/yr.)
# of plants	many (30-50/yr.)	few (5-20/yr.)
matured plants used	many	few
storage period	more and longer	shorter
labor for processing	hire labor	family and exchange labor
6. Non-Farm Activities		
types	None or few	involved in off-farm activity e.g., crafts, selling labor
7. Diet		
contribution to diet	cereals > enset	enset > cereals
food availability	high	low
period unavailable	shorter	longer
8. Sales/Income		
sales	cereals > enset	no enset products sold
		sharecropped cereals sold
income	higher + savings	low and no savings

The diversity and number of livestock is greater than in the other areas studied. Because of cereals, oxen for ploughing are essential. In addition to cattle, rich households have oxen, as well as horses, donkeys, mules, and sheep. Poor households have few animals and have to "share-raise" a cow or calf loaned by the rich. They might rent/sharecrop their small land parcels that are not planted in enset to richer farmers for cereals production. The poor also sell crafts and their labor for food and cash (Figure 10.7).

Figure 10.8 shows that Hadiya I farmers transplant more frequently, and have wider spacing (some using row planting, as opposed to random planting, which is the norm), better management, manuring, and disease control measures. Bacterial wilt is a problem for many farmers, but the wealthy have the choice of discarding, processing, selling, or giving away diseased plants. Poorer households often are the recip-

Figure 10.8 Hadiya (Ana Lemo PA): Systems Differences in Enset Management Practices

	HADIYA SYSTEM 1	HADIYA SYSTEM 2
1. Clone Propagation		
	more plants are available	fewer plants are available
	more clones are available	limited number of clones available
2. Transplanting (3 to 4 times)		
	frequency (2 times)	less frequent
3. Planting Methods		
	some use row planting	random planting
4. Plant Density		
	use wide spacing	use closer spacing
5. Weeding/Cultivation		
	better managed	weakly managed
6. Manuring/Fertilization		
	well manured	poorly manured
	ring application	broadcast application
	season specific application	year round application
7. Leaf Removal		
	fewer removed	more severe removal
8. Intercropping		
	monocropping	some intercropping because of land shortage
9. Diseases and Pests		
	(bacteria wilt in 50%)	(bacterial wilt in 50%)
	sanitary measures: better awareness	poorer awareness
	fencing present	no fencing
	can uproot and dispose of	does not uproot or dispose of
	bunds around plants	no bunds



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ients, which could contribute to the spread of the disease on their farms. Animals pests also attack enset, but richer farmers build bunds around the plants. The rich have more enset clones (Figure 10.9) than the middle and poor wealth categories.

Women in wealthier households are enset farm managers; they pay poor women to do their processing. A starter (*gamama*) is used in processing enset. Figure 10.10 shows that the rich and middle groups process less often (two to three times per year) using large quantities of plants, while the poorer households process small and more immature plants more frequently. None of the poor store *kocho* over a year, and these households are frequently short of food.

Figure 10.9 Clones by Wealth Category, Ana Lemo PA, Hadiya (in percent)

Clone Name	Rich	Middle	Poor/	Mean
1. Gimbo	100	100	86	95
2. Siskela	100	75	86	87
3. Shate	20			7
4. Gishira	80	25	29	45
5. Agade	40	25		22
6. Sapara	80	50	57	62
7. Oniya	60	25	29	38
8. Unjama	100		14	38
9. Disho	80	100	25	81
10. Kaseta		25		8
11. Astara	60		14	25
12. Sormanicho			29	10
13. Torora	20	25		15
14. Tebuta			14	5
15. Bedadedda		25		8
16. Zobra	60	25		28
17. Hayiwona	80	75	29	61
18. Woshamada	40			13
19. Gariya	20		7	
20. Mesmesicho	20			7
21. Kembotra	20			7
22. Mariye	40			13
23. Merjia	40			13
24. Merza	20		7	
25. Mandulk	20	25	14	20
26. Bosina	20	25	15	
27. Ashamosa		25		8

Source: adapted from Spring et al. 1996.

Figure 10.10 Number of Plants Processed and Length of Storage by Wealth Category, Yeferezye PA, Gurage

Wealth Category	Processing				Storage		
	Total Plants	Oct. to Jan.	Aug	April to June	<1 year	1 to 2 years	>2 years
Rich							
Mean	43	31	7	5		40%	60%
Middle							
Mean	51	29	12	10		34%	66%
Poor							
Mean	22	10	8	5	100%		

Source: adapted from Spring et al. 1996.



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Figure 10.11 Wealth Ranking by Community Leaders, Boa Badagallo PA, Sidama

Wealth Stratification	Wealth Indicators	%
Duresa (Rich)	<ul style="list-style-type: none"> • Land size more than 1 ha • Land use very efficient • 4 cows • 2 sheep • 1 donkey • Housing type large and well managed • Plants 800 to 1000 suckers per year • Has all stages of enset that is well structured • Harvests more than 4.8 qts = 480 kg of unhulled coffee in addition to amount for household use 	20
Mererima (Middle)	<ul style="list-style-type: none"> • Land size = 0.5 ha • Land use efficient • 2 cows • 1 sheep • 1 donkey • Housing type medium • Plants 400 suckers per year • Has all stages of enset that is well structured • Harvests more than 3.6 qts = 360 kg of unhulled coffee in addition to amount for household use 	35
Buticho (Poor)	<ul style="list-style-type: none"> • Land size <=0.25 • land use inefficient • 1 or no cow • House type small and poor quality • Plants 50 suckers • Does not have all stages of enset • Enset plantings are not well structured • Harvests only enough coffee for household use 	45

Source: adapted from Spring et al. 1996.

■ What was found in the Sidama Case Study?

Similar to the Gurage, the Sidama system is entirely enset based, and there is some variation between households. Farm size and livestock numbers in general are smaller than in the other areas studied, but wealthier households have larger, more diversified holdings and cash crops. Enset is planted randomly and often intercropped with coffee, vine crops, and fruit trees. There is no erosion because there are neither ox ploughing nor annual crops, and the enset fields are well mulched and manured. This area seems to be the most innovative in its adoption of new technologies, as a result of farmers being organized into coffee cooperatives and having steady incomes. Community leaders estimate that 20 percent of households (compared to 15

Figure 10.12 Enset Farming System in Boa Badgallo PA, Sidama

1. Cropping System		
Enset-dominated (diet, land allocation)		
Coffee as cash crop (next to enset in land allocation)		
Fruit trees, sugar cane, chat for supplementary cash		
Maize, haricot bean, yam taro for supplementary food for rich		
2. Enset System		
Clones	wider diversity in rich	lower diversity in poor
Stage of enset	all in rich HHs	some in poor HHs
Management	rich: better cultivation in rich	poor: worse cultivation
3. Livestock		
Use	milk, manure, sale	
Rich	own cows, sheep, goats, calves	
Poor	few or none, acquire from rich by loan for manure	
4. Manure		
Type	rich: inorganic and manure	poor: manure
5. Processing/Harvesting/Storage		
Frequency	2 times/year,	short time
/storage:	long time	
Labor	hire or exchange labor	household only
Pits	many and wide	few
6. Food Availability		
Rich HHs	wider range and longer period (Aug. to April)	
Poor HHs	narrower range and shorter period (Aug. to Jan.)	
7. Diet		
Enset dependent for all HHs, but rich can supplement with cereals		
8. Sales/Income		
Rich	high—coffee (dried), fruit trees, sugar cane, livestock, chat	
Poor	low for coffee (fresh), non-farm and off-farm crafts/work	
9. Expenditures		
Rich	diverse foods throughout the year, clothes	
Poor	purchase food and earn income for shorter period	
Savings	high for rich	low for poor

percent for Gurage and 8 percent for Hadiya) are in the rich category (Figure 10.11). The number of livestock is declining on a per household basis as grazing lands became scarcer because of increasing human population. Cows, the main livestock type, are tethered in front of the house. Poor households are cattle-deficient and might borrow a cow for manure and dairy products. Wealthier farmers are purchasing inorganic fertilizer (DAP) to make up for cattle manure deficiencies. Although enset is still the preferred food (Figure 10.12), households also supplement their diets with cereals (usually maize) and other foods.



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Figure 10.13 Enset Management System Forms a Continuum on Many Variables, Boa Badagallo PA, Sidama

1. Clones		
number and types	diversified	less diversified
Plantation size	large	small
2. Transplanting		
Frequency	1 and 2 times	
3. Planting Method		
planting type	all have random, unstructured	
4. Plant Density		
	all have close spacing	
5. Weeding/Cultivation		
management	good	poor
6. Manuring/Fertilization		
application	one side application	
method	and broadcasting	
types	cattle manure	inorganic (DAP)
7. Leaf Removal		
removal	little	severe
8. Intercropping		
intercropping	some crops	all crops are
9. Diseases and Pests		
bacterial wilt	less serious for all	
awareness of sanitary		
measures	little	some
fencing	well fenced	not well fenced

Enset management practices are correlated with wealth categories, farming skills, and availability of resources, and there is variation in intercropping, fencing, and manuring (Figure 10.13). This zone has the lowest incidence of bacterial wilt, and farmers seem to know about its spread by contaminated tools. There is little erosion, even on farms planted on slopes. Unlike other enset growing areas, farmers purchase enset suckers from highland farms rather than using their own. The rich have more clones than the middle and poor farmers (Figure 10.14).

A starter (*gamacho*) is used to ferment *kocho*, and many farmers put the storage pits inside their homes to prevent theft. Women are beginning to use iron scrapers instead of bamboo ones for decortication and cloth squeezers for *bulla*.

Figure 10.14 Clones by Wealth Category of Households, Boa Badagallo PA, Sidama (in per-

Clone Name	Rich	Middle	Poor/	Mean
1. Ado	100	100	100	100
2. Genticha	100	100	100	100
3. Midasho	80	40		40
4. Ewasho	100	80	67	82
5. Gullumo	20		17	12
6. Mindraro	20			7
7. Agana	20		17	12
8. Chacho	40	60	33	
9. Medie	60		33	31
10. Birra	40			13
11. Derassie-Ado	40		17	19
12. Gossalo	40	20	17	19
13. Gedimie				7
14. Gena	20		17	12
15. Hekechie	20			7
16. Haho	20			7
17. Gerbo	20			7
18. Kitickha	20			7
19. Siriro	20			7
20. Arisho	20			7

Source: adapted from Spring et al. 1996.

■ What conclusions can be drawn about systems variation from the case studies?

Between ethnic groups where enset is a staple (Gurage and Sidama) and a co-staple for some of the population (the wealthier households among the Hadiya) there are differences in many aspects of enset cultivation (clonal variation, plant spacing, disease prevalence, and manuring) and processing (tools and starter used, location, size, and disease of pits). The gender division of labor varies between groups and households, and there are differences in the mix of farm, off-farm, and non-farm enterprises.

Most differences in enset systems have been attributed to altitude. These case study data show that within an area, variation can be found based on household resources and farm enterprises, rather than only on altitudinal differences. Wealthier households have resources to maintain self-sufficiency, educate their children, vary their diets (changing to a cereal-based diet, if they chose), hire labor for farming and processing, and build many houses. They cope better with enset and livestock diseases because of diversification of



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clones and livestock. Poorer households lack clonal variation, are dependent on the richer ones for work and livestock to share-raise, and consume only enset-based diets with few protein sources. They work for others, have little cash or consumer goods, and are vulnerable to disease and shortages.

Land holding size is another key element determining the amount of enset and other crops planted, as well as available grazing land for livestock. The rich have the largest amount of land and enset plantations per household, followed by smaller amounts for the middle, and very small amounts (often only enset fields) for the poor and very poor. Land size strongly correlates with wealth, although community leaders list livestock, enset plants, and cash as the indicators.

Wealthier households have greater clonal variation, as well as having more mature and a larger number of enset plants (future research will determine if clonal variation is an advantage or something like a status symbol that the wealthy can better afford). They have other income sources, a more diverse diet, and an obligation to help the poor by giving them livestock to "share-raise." They process larger numbers of enset plants infrequently, and do not experience famine, unlike poorer households, which have shortages

from time to time. Women in wealthier households reduce the drudgery of enset processing by hiring labor. Poor women have the double burden of working and processing on their own farms and selling their labor for such tasks to wealthier households.

There are no technical packages or extension advice on enset production being promoted to farmers. But innovation and intensification are occurring in small ways, particularly among the Sidama, where increasing population growth produces severe land shortages (even to the point of using grazing lands for settlement and enset cultivation). Sidama farmers with cash from coffee sales are purchasing inorganic fertilizers, and women are changing the location of pits and adopting an improved scraper. Gurage farmers are exploiting increased interest in enset by urban dwellers, by sending surpluses to Addis Ababa.

FOOD SECURITY AND SUSTAINABILITY

■ How do enset-based farming systems contribute to food security in Ethiopia?

Enset-based farming systems play an important role in food security in Ethiopia. The exact role and value relative to other farming systems cannot be addressed without examining enset production and consumption in relation to the concept of food security. Food security can be explained in terms of: 1) adequate availability of food in line with present population and demographic growth; 2) the nutritional adequacy of food intake; 3) annual stability of the food supply; 4) access to food (through production or the market) (Brandt, 1990; Webb and von Braun, 1994; and FAO, 1996); and 5) the sustainability of the food production capacity over the long term. Each of these five features relating to food security is discussed briefly.

Some of the most dense rural populations of Ethiopia are located in regions practicing enset-based farming in the southwestern highlands. Rahmato (1996) notes that among the Wolayta, as landholding size declines, there is an increase in the cultivation of enset. These observations indicate that the human carrying capacity (i.e., the number of people per unit of land area that can be adequately fed by the food produced on the same land area) of enset and enset-based farming systems is high and is likely greater than other crops and cropping systems for the same agroecology and inputs.

■ How does the quantity and quality of human food produced from enset in enset-based systems affect potential human carrying capacity as compared to other systems?

Although enset-based farming systems seem to support higher population densities than other farming systems, it is difficult to compare these systems, because of a lack of quantitative research data. The human carrying capacity of enset-based agricultural systems is more difficult to quantify than systems based on annual cereal crops for at least four reasons: 1) enset yields are difficult to determine and have not been quantified; 2) enset food products have a low, inadequately-verified, protein content with an unknown amino acid distribution; 3) enset's low protein content necessitates that the protein contribution from associated foods be more diligently considered; and 4) nutrient cycling among enset fields and other fields are not yet evaluated.

Enset yields are difficult to measure and evaluate because: 1) plants are grown for multiple and variable numbers of years; 2) the spacing of individual plants may be changed several times; 3) enset may be grown in complex mixtures with other species, as well as other enset clones and other sized enset plants; 4) the weight gain of food in an enset plantation for a year may not be the same as the amount harvested by the farmers during that year; and 5) in addition to human food, there are many other enset products obtained from each plant. Also, the huge volume harvested from one plant and from an area, particularly in relationship to cereals, contributes to the perception among both farmers and scientists that the yield of enset is tremendous. However, in reality, the content of water, energy, and protein, the area and time use by the plants, as well as other aspects must be considered in order to interpret the actual food yield from this huge volume. Box 11.1 and Figure 11.1 provide an example of the complexity of evaluating enset yield. This example shows that the average annual yield of 34 farms was 5,000 kilograms of *kocho* per hectare, in addition to other products that were not measured, such as fiber and animal feed.

Yield and human carrying capacity of enset and annual



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crops under the same conditions have not been compared. In such a comparison, at least two considerations must be made. First, enset usually grows in regions with a long growing season, commonly nine months. In the environments where it is possible to double crop and get two annual crops, yield and human carrying capacity of enset should be compared to a sequence of two crops. Second, comparisons of human carrying capacity should consider the abilities of the systems to supply the nutrients, particularly energy and protein, required by humans.

The importance of considering the requirements and supplies of both energy and protein in determining human carrying capacity are illustrated in Box 11.2 and Figures 11.2 and 11.3 with a comparison of two hypothetical cropping systems, i.e., 1) enset and dry bean and 2) maize/sweet potato and dry bean. To simplify the example, only crops are included; but the relevance of consuming high-protein animal food products with low-protein *kocho* is apparent.

From the comparison of enset and bean with maize/sweet potato and bean (Box 11.1 and Figures 11.2 and 11.3), it

can be seen that comparing just the yields or energy content of enset with maize/sweet potato is inadequate for determining the ability of the crop to support dense human populations. Even at the highest protein content, the enset, at 5,000 kilograms of *kocho* per hectare per year, and bean support 15.5 adults per hectare, while the maize/sweet potato, at 4,000 kilograms per hectare per year, and bean support 18.2 adults per hectare. Another concern is the amount of bean required in the enset diet. The required bean consumption of 53 to 71 kilograms per year is two to three times greater than the amount provided by a typical African diet, which is 10 to 26 kilograms per year of pulses plus groundnuts (Aykroyd *et al*, 1982). Thus a diet with a large proportion of enset may require the addition of a higher protein source than bean, which is why high-protein animal food products are so important in this system. A serious concern in enset producing regions, is that as population density or poverty increases, the opposite may be occurring—consumption of *kocho* increases while consumption of animal products decreases.

Box 11.1 Examples of enset yield calculations, with reference to water content use of area area and time

Using *kocho* weights, from a sample of five plants from each of 34 farms (17 near Emdibir, 10 in Kambata, and 7 in Sidama) (Makiso, 1976), yield is calculated (Hiebsch, 1996) as dry weight per unit area per unit time [e.g., kg/(ha yr)], based on the farmers' transplant management presented by Makiso (1976) (Figure 11.1). In this three transplant system, suckers develop during the first year from the mother corms; the suckers are transplanted (1st transplant) to a 1.0 m X 0.5 m spacing for one year; then the plants that are still alive are transplanted (2nd transplant) to a 1.5 m X 1.5 m spacing for two years; and then transplanted (3rd transplant) to a 2.5 m X 2.5 m spacing for four years; for a total of eight years. Personal observations in similar locations indicate that the plant management in Figure 11.1 is stylized and simplified, as there is variation among the locations, farms, and plants on a farm and some enset is intercropped.

The example in Figure 11.1 is designed to provide most of the food energy required by a family of five to six from *kocho*. Although fermented *kocho* contains about 50 percent water, the calculated yield is for dry, i.e., waterless, *kocho*, since water does not provide energy. Each year, 80 eight-year-old plants, which utilized a total of 2,455 m²/yr as they passed through the eight stage/years, are harvested from the 4th-year, 3rd-transplant plot of 500 m². In order to harvest 80 plants each year, and continue on into the future, all eight stage/years must be present each year, thus requiring 2,455 m² each year, i.e., 2,455 m²-X-1 yr = 2,455 m² yr. Thus, the same area-X-time is required for the 80 harvested plants during their eight years as for all stages/years in a given year. Therefore, yield is the dry weight of *kocho* produced by the 80 plant divided by the total area-X-time required to produce them, i.e., 2,455 m² yr. Based on these estimates of water content, spacing, and timing, the average yields for the 34 farms was 5,000 kg dry *kocho*/(ha yr). Yields from highly managed research plots (Bezuneh, 1984) range from 5,900 to 9,500 kg of dry *kocho*/(ha yr).



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■ How does the quantity and quality of animal feed produced from enset in enset-based systems affect potential human carrying capacity as compared to other systems?

The low-protein portion of an enset plant is eaten by humans and the high-protein portion is either recycled to the soil, used as a wrapping material, or fed to animals. Thus the entire cycling of protein through other components of the system, particularly animals, has a greater impact on human nutrition and human carrying capacity than in cereal-based systems, in which the high-protein portion is eaten by humans.

Human food from mature enset plants comes primarily from the corm and an extracted pulp from pseudostem leaf sheaths. Together the corm and leaf sheaths have 0.037 kilograms of protein per kilogram of dry matter (Fekadu, 1996). The remainder of the plant, which is mostly leaves, is about

26 percent of the plant, and contains 0.160 kilograms of protein per kilogram of dry matter. Therefore, both the protein content and the total amount of protein is greater in the portion not eaten by humans. The recycling of all these products (non-human portions, human foods, and animal manure) all have important consequences for the human carrying capacity of the system. By comparison, the stems and any remaining leaves of cereals and other tuber crops that are left for animal feed are usually of low protein value and in some cases are unacceptable as animal feeds.

Nitrogen, which is 16 percent of the protein, is often the most limiting chemical element in a farming system. In the enset system, the larger portion of the nitrogen does not pass directly from the enset plant to humans. Rather, it is cycled through animals. Therefore a quantitative understanding of the cycling of nitrogen in the enset system is difficult to measure, but important.

Figure 11.1 Estimate of dry *kocho* yield (weight/(area-X-time), based on fresh *kocho* yield (weight/plant) measured on 34 farms, using a simplified and stylized, three-transplant management system of enset; represented with an annual harvest of 80 plants, that is sufficient to supply the food energy for a five to six person household.

Stage †	Year		No. of Plants ‡	Spacing for each plant (m X m)	Area-X-time for each stage/year † (m² yr)
	for a stage †	total			
----- stage/year -----					
Sucker nursery	1	1	5	1.0 X 1.0	5
1st transplant	1	2	100	1.0 X 0.5	50
2nd transplant	1	3	89	1.5 X 1.5	200
	2	4	89	1.5 X 1.5	200
3rd transplant	1	5	80	2.5 X 2.5	500
	2	6	80	2.5 X 2.5	500
	3	7	80	2.5 X 2.5	500
(harvested plants)	4	8	80	2.5 X 2.5	500
Total area-X-time					2455

$$\text{Yield} = \left(\frac{30.6 \text{ kg fresh } kocho}{\text{plant}} \right) \left(\frac{0.5 \text{ kg dry } kocho}{1.0 \text{ kg fresh } kocho} \right) \left(\frac{80 \text{ plants}}{2455 \text{ m}^2 \text{ yr}} \right) = \frac{0.5 \text{ kg dry } kocho}{\text{m}^2 \text{ yr}}$$

$$\text{Yield} = \left(\frac{0.5 \text{ kg dry } kocho}{\text{m}^2 \text{ yr}} \right) \left(\frac{10000 \text{ m}^2}{\text{ha}} \right) = \frac{5000 \text{ kg dry } kocho}{\text{ha yr}}$$

† The 80 plants harvested at the end of 8 years (4th year of 3rd transplant) went through all 8 stage/years; all 8 stage/years are present each year so that 80 plants can be harvested per year into the future.

‡ Assumes that 5 mother corms in the sucker nursery produce 100 robust seedlings; and assumes approximately 10% loss of plants at each transplanting.

Source: Makiso (1976) and Hiebsch (1996)



■ How does enset contribute to the stability of the annual food supply and reduce food shortages, particularly during drought years?

The presence of enset in the farming system contributes significantly to the stability of the food supply by several mechanisms. Enset can: 1) be stored for long periods; 2) be harvested at any time during the year; 3) be harvested at any stage over a several year period; and 4) survive stress years that reduce other food sources. It could even be argued that since enset requires from three to over ten years to mature, the frame of mind required to produce enset contributes to a general prepare-for-

the-future mentality, which has other behavioral consequences.

As described in the section on processing, *kocho* is stored in nearly-airtight “containers” (i.e., pits), in a fermented state, which greatly retards loss. Farmers report that *kocho* may be kept for several years in this way. It is important to note, however, that only the wealthier households may actually store *kocho* for more than one year (Spring *et al.*, 1996; and above); this product may be a status symbol analogous to an aged wine for special occasions.

Mid-season food shortages can be alleviated because enset can be harvested at any time during the year. If *kocho* is going to be prepared, then the farmer must plan ahead by

Box 11.2 Comparing enset to other crops

The objective is to determine how many adults can be supported on one ha of land based on energy and protein requirements and production. The two systems are (1) enset and a double crop of two dry bean (*Phaseolus vulgaris*) crops, and (2) a double crop of maize followed by sweet potato and a double crop of dry beans. The enset used in this example is illustrated in Figure 11.1 and has a *kocho* yield of 5,000 kg/(ha yr). In support of an untested hypothesis that enset has higher yields than a double crop, the maize and sweet potato are assumed to yield 2,000 kg each of dry edible food/ha, for a total of 4,000 kg/(ha yr), or 1,000 kg/(ha yr) less than enset. The diet from system (2) has equal portions of maize and sweet potato. The yield of the bean is assumed to be 800 kg/ha for each of two crops per year for a total of 1,600 kg/(ha yr).

The requirements for an adult human used in this example are (2,200 kcal/day) X (365 days/yr), or approximately 800,000 kcal/yr for energy (FAO/WHO, 1973) and (0.050 kg/day) X (365 days/yr), or approximately 18 kg/yr for protein (NRC, 1989). Since the energy contents of *kocho*, maize and sweet potato, and bean are similar, the energy yield and the number of adults that could be supported based on energy are closely related to the food yield, e.g., enset produces 19,000,000 kcal/ha and has enough energy to support 23.8 adults/ha (Figure 11.2). Protein yield, however, produces quite a different picture. Reported *kocho* protein content varies by more than three-fold from 0.012 to 0.037 kg of protein/kg of dry *kocho* (by comparison, cassava is 0.030 and maize is 0.108 kg of protein/kg of dry food). Although with most foods, protein content has been verified repeatedly, with *kocho* it is not known whether the variation reported is due to actual protein content differences or to the laboratory techniques. The amount of protein produced by the crops is quite variable, with enough for 3.3 adult/ha at the 0.012 kg of protein/kg value for *kocho* and 20.4 adults/ha for beans.

In either of the *kocho*-based or maize/sweet potato-based system, a proper quantity of bean can be combined to provide the required energy and protein. These combinations for *kocho* at the three protein levels and for maize/sweet potato are indicated under “weight of food” in Table 11.3. For example, at a protein content in *kocho* of 0.029 kg/kg, 150 kg of *kocho* and 59 kg of bean will provide the required 800,000 kcal and 18 kg of protein. The land areas required to produce those quantities of carbohydrate-rich food and bean are indicated under “land required to feed 1 adult.” For example, 0.030 ha of land is required to produce 150 kg of *kocho* and 0.037 ha to produce 59 kg of bean, for a total of 0.067 ha/adult. Potential human carrying capacity (adult/ha) is the inverse of ha/adult and ranges from 13.9 for the lowest protein value for *kocho* to 18.2 for maize/sweet potato. In order for enset and bean to have the same human carrying capacity as maize/sweet potato and bean (i.e., 18.2 adults/ha), the yields of *kocho* would need to be between 7,200 and 13,100 kg/(ha yr), as compared to 4,000 kg/(ha yr) for maize and sweet potato combined.



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Figure 11.2 Nutrient content, yield, and supply of dry kocho from enset, maize, sweet potato, and bean.

Product	Nutrient content [†]				Annual Nutrient yield [‡]		Number of adults that can be supplied with [*]	
	Energy kcal/kg	Protein ----- kg/kg of food	Carbo- hydrate	Fat -----	Energy Xcal/ha [§]	Protein kg/ha	Energy ----- adult/ha	Protein -----
Carbohydrate-rich food								
• <i>kocho</i>	3,800	0.012 [†]	0.96	<0.01	19.0	60	23.8	3.3
		0.029 [†]				145	8.1	
		0.037 [†]				185	10.3	
• maize	4,100	0.108	0.83	0.05				
• sweet potato	4,000	0.052	0.93	0.01				
• average of maize & sweet potato	4,050	0.080	0.88	0.03	16.2	320	20.3	17.8
Protein-rich food								
dry bean	3,900	0.230	0.72	0.01	6.2	368	7.8	20.4

[†] Reported protein contents of *kocho* are, in kg of protein/kg of dry food, 0.012 (ENI 1981), 0.029 (Pijls 1994), and 0.037 (Besrat 1979); other nutrient contents of *kocho* (ENI 1981); nutrient contents of other crops (various sources).

[‡] Nutrient yield for energy and protein is based on dry food yields of
 (1) 5,000 kg/(ha yr) for *kocho*,
 (2) 4,000 kg/(ha yr) for a double crop of maize and sweet potato combined, and
 (3) 1,600 kg/(ha yr) for two crops of dry bean that are double cropped.

[§] Nutrient yield is calculated by multiplying dry food yields by nutrient content, e.g.,
 kg of food/(ha yr) X kcal/kg of food = kcal/(ha yr), thus
 5,000 kg *kocho*/(ha yr) X 3,800 kcal/kg of *kocho* = 19,000,000 kcal/(ha yr).
 Units for annual energy yield, indicated as Xcal/ha, are millions of kcal/ha.

^{*} Number of adults (adult/ha) that can be supplied with energy or protein is based on either:
 (1) an energy requirement for one adult of (2,200 kcal/day) X (365 days/yr) for approximately 800,000 kcal/yr or
 (2) a protein requirement for one adult of (0.050 kg/day) X (365 days/yr) for approximately 18 kg/yr. Since amino acid content and protein digestibility in *kocho* are not known, to prevent underestimating protein requirements, minimum protein requirements of 0.030 kg/(adult day) reported by FAO/WHO (1973) are not used in this example.

Number of adults (adult/ha) that can be supplied with energy or protein is calculated by dividing nutrient yield by the energy or protein requirements of an adult, e.g., based on energy from *kocho*, [19,000,000 kcal/(ha yr)]/[800,000 kcal/(adult yr)] = 23.75 adult/ha.



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Figure 11.3 Weight of (1) kocho and bean or (2) maize/sweet potato and bean necessary to provide the adult requirements of 800,000 kcal[†] and 18 kg protein[‡] per year; land requirement and potential human carrying capacity.

Foods	“Carbohydrate Food” (kg protein/kg dry food)			
	(0.012)	kocho (0.029)	(0.037)	maize & sweet potato (0.080)
	Weight of Food (kg food/yr)[‡]			
“carbohydrate food”	138	150	156	184
bean	71	59	53	14
total	209	209	209	198
	Assumed Yields [kg/(ha yr)]			
“carbohydrate food”	5000	5000	5000	4000
bean (2 crops/yr)	1600	1600	1600	1600
	Land Area Required to Feed 1 Adult (ha)[§]			
“carbohydrate food”	0.028	0.030	0.031	0.046
bean	0.044	0.037	0.033	0.009
total	0.072	0.067	0.064	0.055
	Potential Human Carrying Capacity (adult/ha)[*]			
	13.9	14.9	15.5	18.2
	Yield of Kocho Required for a Potential Human Carrying Capacity of 18.2 adults/ha [kg/(ha yr)][#]			
	13,100	8400	7200	—

[†] Requirements: (2200 kcal/day)(365 day/yr) ≈ 800,000 kcal/yr (et in [‡]);
(0.050 kg protein/day)(365 day/yr) ≈ 18 kg protein/yr (pt in [‡])

[‡] Weight of the carbohydrate food (c) and bean (b) solved by simultaneous equations:
 $e_t = e_c c + e_b b$ and $p_t = p_c c + p_b b$, where e is the energy (kcal) and p is the protein required in total (t) and based on the contents in the “carbohydrate food” (c) and bean (b); the total (e_t or p_t) is the sum of energy or protein from c and b.

[§] Land area (a): $a_c = c/y_c$, $a_b = b/y_b$, $a_t = a_c + a_b$, where y’s are the assumed yields.

^{*} Human carrying capacity (HCC): $HCC = 1/a_t$.

[#] Yield (y) of kocho (y_k) required to have HCC equal to maize/sweet potato and bean (HCC_2) i.e., 18.2 adults/ha: $y_k = e_k HCC_2 / (1.0 - MCC_2 b/y_b)$.



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about one month as this is required by the fermentation process. If the plants are harvested for *amicho*, they may be used immediately. Because of the storage and harvest-timing characteristics of enset, if a farmer has enough enset plants, there is no “hunger period” as is common in cereal farming.

The last two mechanisms, which work together, are probably more important for adding stability to the year-to-year food supply. Enset can be eaten at any stage of growth, over a several-year period after the corm reaches about 10 to 15 centimeters in diameter. Under good growing conditions, this condition may occur during the first transplant stage. There is great variation among ethnic groups as to both the acceptability and the practice of harvesting young enset plants. In years when other foods are in short supply, usually caused by drought, more enset plants may be harvested than was originally intended. For example, in the system described in Figure 11.1, the harvest may include the 80 plants in the fourth year of the third transplant stage, as well as any number of younger plants. However, the younger plants harvested will not be available to harvest in the future. At the beginning of the next growing season, the farmer will likely need to implement a strategy to recover. The enset plants themselves may also contribute to the recovery, since the remaining enset plants in the “prematurely” harvested field may grow faster during the next season because of lower plant density and reduced competition. Although these last two mechanisms may provide great stability to the food supply in an enset-based farming system, no research has been conducted either on the effect of “early” harvest of enset on present and future food supplies or on strategies implemented by farmers that are facilitated by these enset characteristics.

In enset producing regions, no matter how small the land holding, enset is grown. Even families referred to as “landless” have a house with enset around it. Enset serves the multiple purposes described above, as well as providing a dependable food source.

■ How does enset contribute to the sustainability of food production?

The ability to provide a long-term, sustainable food supply, with minimum off-farm input, is probably the most noteworthy characteristic of enset, and is a primary motivation for this publication and current interest in enset. An obvious and principal contribution to sustainability is the minimal soil erosion involved in enset’s cultivation. Enset provides a perennial leaf canopy over the soil and a heavy mulch cover from leaf litter. Soil erosion is not seen in enset fields. This

situation is in stark contrast to fields of annual crops, particularly at the beginning of the rainy season when there is no soil cover by the annual crop. The perennial leaf canopy also may reduce maximum soil temperatures and, thereby, decrease organic matter decomposition rates. There are no research data to support these common visual observations of reduced soil erosion.

A curious aspect related to soil erosion is that enset is most commonly planted around the house, and the house is usually on the most level location on a farm. If there is slope variation on a farm, annual crops commonly occupy steeper fields than enset. Therefore the soil erosion observed in enset versus annual crops is not just related to the crop. There is a need for research comparing enset and annuals on sloping fields. If suspicions are confirmed, extension activities need to be implemented to encourage more production of enset on erosive locations.

Leaching losses of plant nutrients, particularly nitrogen, may be reduced by enset as compared to annual crops. This should be possible because of the continuous soil occupation by roots. At the beginning of the rainy season and after maturation, annual crops have little root proliferation and little affect on nutrient leaching. For established enset, roots already proliferate the soil profile at the beginning of the rainy season. Also the large mass of the plant should serve as a storage reserve, reducing the availability of the nutrients in the soil for leaching.

The main negative feature of enset, its low protein content in the human-food portion, may contribute positively to its sustainability. Soils are depleted with continual removal of crop products. This is common with off-farm sales or with on-farm consumption without recycling of waste products, including human excrement. Removing low-protein (low-nitrogen) *kocho* from a site should have less impact on the nitrogen status of the soils than removing cereal crops, as long as the high-nitrogen portion is cycled within the farm.

It is common to find enset fields that have been productive for decades. The mechanisms that allow this long-term high productivity with minimum external inputs need a great deal of future study with the objectives of improving the enset system and transferring components of its success to other systems.

FUTURE PROSPECTS

■ Who will benefit most from greater knowledge of and improvements in the enset systems?

The most directly and significantly affected stakeholders to benefit from accelerated research and development activities related to enset systems are the subsistence farm family and the local communities. Several characteristics of the enset plant and systems described above, e.g., a large stored food supply available when other foods are in short supply, are particularly valuable for subsistence, low-resource farmers living in a highly variable environment. However, Ethiopian society as a whole also benefits because of the preservation of natural resources through wise management of the enset systems.

■ What is the potential of enset products playing a larger role in the diet of the urban populace?

During the last two decades, two things have happened to make enset food products significantly more popular among the urban populace of Addis Ababa and surrounding communities. First, the grain markets have experienced a considerable increase in the price of cereals, while the price of *kocho* has remained relatively constant. Urbanites shopping in the markets of Addis Ababa, especially those from enset-growing regions, are choosing to purchase enset products both for taste and to make their limited incomes go further. Although considerably more research needs to be done on the marketing and pricing of enset products, a cursory survey of sellers at the main market, *Mercato*, revealed over 120 women sellers of *kocho* and *bulla*.

Second, there has been a breakdown in the cultural perception of enset food products as “peasant food.” As previously mentioned, *kocho* has become extremely popular at restaurants and is almost “required” to be eaten together with the Ethiopian delicacy of *kitfo* (raw, ground beef mixed

with butter and spices). Informal interviews and observations at a sample of Addis Ababa restaurants indicate those establishments that specialize in often run out of high quality *kocho* due to poorly developed enset marketing and transport systems. All of this suggests there could be considerable opportunity for supplying and increasing the demand for enset in urban markets.

■ What is the potential of enset cultivation being introduced or re-established in regions outside its main area of use?

In a study of agriculture in the former Illubabor region of southwestern Ethiopia, the Sombo peoples, who traditionally were cereal farmers dependent upon t’eff and maize, experienced two starvation periods (Ishihara, 1993). The second was in 1984-85 when the peasants migrated from their villages in search of food, a considerable number of them dying on the way. Some traveled as far as Wolliso, where they learned how to cultivate enset. Returning to Sombo, they introduced enset agriculture, and *kocho* soon became an important part of their diet. In 1992, when cereal crops were severely damaged by excessive rainfall, they lost 50 to 90 percent of their cereal harvest and most of their coffee beans to disease. However, they were able to avoid famine because of their increased dependence upon enset. This case suggests that fear of hunger and starvation can be a powerful incentive to try to grow a new crop, even a multiyear one such as enset.

The northern town of Lalibela, famous for its eleventh century rock-hewn churches, is also the site where thousands of people died as a result of the mid-1980s famine. Some farmers in Lalibela grow a few enset plants near their houses (Plate 9) in order to use the leaves to wrap bread for baking. Like other northern Ethiopian farmers, those farmers contacted had no knowledge of enset as food. Surprised to learn that enset could be eaten, they expressed interest in learning to cultivate and process enset for food as a means of increasing food security.



However, before enset farming can be introduced to new areas, a systematic survey throughout Ethiopia of the distribution of wild and cultivated enset, as well as a study of the history of enset use, should be undertaken. Trial farms would need to be established where the mechanisms for introducing planting materials, cultivation and processing techniques, and cooking methods are provided. An adequate number of livestock would also have to be available for the production of manure and milk products. Furthermore, remaining social stigmas about eating a fermented product or a “peasant food” would have to be overcome.

■ What extension and development work could be implemented in the near future to assist enset farmers?

Based on the research carried out so far, there are many potential future interventions. These can be grouped into the following unranked categories: A) extension information to farmers concerning enset diseases; B) improvement and mechanization of enset processing; C) improved livestock breeds, pastures, and health and nutrition; D) increased and improved production of protein-rich food crops; and E) marketing assistance for enset products and improving transportation and retailing networks.

A. Extension information to farmers concerning enset diseases: Chief among the important topics is an extension campaign to educate both women and men farmers about the nature and spread of bacterial wilt disease. Disease control requires an integrated approach by the farmer and the farm community. Disease, particularly bacterial wilt, is not controlled by outside inputs, but rather by a commitment on the part of the farmer to follow proper sanitary procedures, e.g., the use of clean cutting and processing tools. This commitment only comes with knowledge and its acceptance. This extension activity has tremendous need and potential benefit—a benefit that will have a spill-over effect into the understanding and prevention of human and animal diseases.

B. Improvement and mechanization of enset processing: The traditional methods of processing may reduce the quality and quantity of enset food and fiber. Research has been conducted in several institutions (the Institute of Agricultural Research at Nazaret and at Awassa, the Ministry of Agriculture, and Awassa

College of Agriculture) to develop improved processing devices. Efforts have been made to modify: 1) the decorticator that separates the leaf-sheath pulp from the fiber; 2) the pulverizer that grates the corm into fine pieces; 3) the kneader that squeezes out unwanted water from fermented *kocho*; and 4) the shredder that chops the fiber present in the fermented *kocho*. Thus far such devices are primarily experimental and have had little testing; farmer acceptance has not occurred because of cost and inaccessibility (Metshen and Abate, 1994). Adoption of these improved tools should be pursued for their value in reducing labor and increasing uniformity of products. There is also potential for its dissemination as part of a cottage industry development package.

C. Improving livestock breeds, animal health/nutrition, and pastures, as well as using enset leaves for enhanced feeds: All too often researchers and extensionists ignore the importance of livestock in maintaining the productivity (and with respect to enset, the sustainability) of agricultural systems. McCorkle (1992) notes that within mixed production systems, researchers have treated cultivation and stock raising in virtual isolation and/or ignorance of one another. Attention to animal nutrition and health, improved pasture and forages, as well as improved breeds and animal culling, would all have positive effects on enset cultivation systems. Farmers themselves ask development personnel and the current researchers for improved veterinary services, especially in regard to animal health. Since so much of the enset system depends on cattle, assistance in improving livestock breeds, training farmers how to cull herds, and providing information, capital, and planting materials for improved pastures and forages are critical. Further, the role of enset leaves as a component of silage and feed concentrates has not been explored, but could have great potential to enhance feed for a variety of livestock.

D. Increased and improved production of protein-rich food crops: Haricot bean, lentil, chickpea, and other seed legumes (pulses) supply protein-rich foods and are already important components of the enset system. One of the main limitations of enset food products is the low protein. There is

already much research data and extension information on the production and utilization of these pulses. On-farm trials are being conducted in the enset region on some of these pulses. The productivity and nutritional quality of the enset system could be improved through a concerted extension effort to increase the production, yield, and utilization of these pulses.

E. Marketing assistance and improving transportation and retailing networks: Little is known as to what could facilitate the marketing of enset food and non-food products at local and urban markets. There are many components of this challenge that need exploration and intervention, including: product supply and demand, transportation infrastructure, supply of capital, market facilities, storage, and packaging.

■ **What research agenda is necessary to improve the understanding of enset-based systems?**

Since enset and enset-based systems have received little study relative to many other crops and systems, the research door is wide open. Much information considered to be baseline for other crops has not been collected with respect to enset. For example, almost no research has been conducted on the effects on growth and yield of different clones; plant density, spacing, and duration at a given spacing; transplanting methods; manure and/or fertilizer amendments; propagation techniques; and environmental conditions (i.e., temperature, water, and sunlight).

While these baseline agronomic topics need to be addressed, several larger issues related to food security and natural resource preservation in Ethiopia must also receive attention. They include: a) the effects on human nutrition as population density and poverty reduce the amount of animal food products and cattle manure, and b) the sustainability of enset systems (in terms of productivity and prevention of soil degradation) as animal manure and other natural resources become more scarce. Furthermore, the human population carrying capacity of the various enset systems under current practices needs study and estimation. Interventions for both the maintenance of the indigenous systems and the intensification of those systems to develop new forms of production and processing require additional research.

Research trials are being carried out under station conditions at Areka Research Station and Awassa Research Center in southwestern Ethiopia (Plate 7). They relate to intercropping, fertilizer input levels, and measurement of yields. On-farm studies, with farmers as trial cooperators, should be implemented, as has been done with cereals, legumes, and tubers (Franzel and Van Horten, 1992). These on-farm, farmer-cooperator trials are particularly important because of the complexity and diversity of enset management at the household level, which, as previously mentioned, are not yet fully understood by research scientists.

■ **What are some of the socioeconomic and gender issues in need of further study?**

Socioeconomic variables and agronomic management practices are intimately related. One current puzzle is why wealthier households have greater clonal variation, as well as a greater number of clones in general. Is it because of their larger land holding size, greater social networks for obtaining more varieties, greater labor to plant and care for larger enset holdings, larger incomes to purchase other varieties, better all-around management practices, or the prerogative of wealth? Research needs to be carried out on the reasons, as well as on the consequences for household and surplus production.

Many of the previous sections noted that more research is needed on a variety of topics. These include the following:

■ **Transplanting methods and harvest management seem to be a function of ethnic group, household needs, and available resources (such as land, labor, capital, and other food crops in the system). But which are the critical dimensions?**

What is the importance of harvesting mature versus immature plants? For example, North Omo male farmers prefer to harvest mature plants, while women of the same group prefer to harvest smaller plants for better taste and ease of fermentation. The reasons for this distinction, whether it is observed in other groups, and the consequences for enset yields need careful analysis.

Since a major constraint on production is bacterial wilt, socioeconomic and gender variables relating to disease



transmission agents (e.g., contamination by cutting and processing tools, livestock, etc.) need to be examined.

The demographic composition of the household, the amount of resources of the total household, as well as the resources of individual members disaggregated by gender need careful study. Access to and control over resources are important to determine, as well as the overall carrying capacity of a given area in terms of population density.

The division of labor by gender and the remuneration received for selling surplus enset products need to be investigated. If men receive the profits from women's processing labor, women's incentives are reduced. The effects of the market on both men and women in terms of planting and processing decisions need to be studied.

Some farmers plant more "female" than "male" plants. This pattern needs to be investigated as to whether or not there are gender-specific reasons for these choices, or if women manage to prevail in their own preferences.

■ What is the future of enset as a sustainable agricultural system?

The present situation in the southern highlands of Ethiopia provides a window into the workings of the issue of sustainability in agricultural systems. Farm households in some areas (e.g., Sidama, Gedeo, and Wolayta) are attempting to deal with the stress of limited land for cultivation and grazing, as well as with rapidly growing populations. As Rahmato (1996) warns for the Wolayta region:

The "triumph" of enset cultivation can now be seen in the demographic mountain it has managed to throw up, and the systematic crisis it has, unwittingly, brought upon itself. Agricultural intensification, the primary response of peasants to resource scarcity and population pressure, has failed to arrest the intensification of competition for resources and the acceleration of demographic expansion. Moreover, while in the past population growth may have stimulated change and adaptability in the enset system, the immense demographic pressure on the land today is unlikely to induce technical progress, and may in fact drive the system toward regression.

Research and development are needed to address sustainability issues and the place of enset as a major contributor to the food security of Ethiopia, or to search for alternative agricultural systems. This research and development partnership needs to accelerate on all fronts that address the biophysical and socioeconomic merits and limitations of the various enset systems.



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