FRP TECHNICAL PAMPHLET NO.1

ENSET IN NORTH OMO REGION

BY

KEFALE ALEMU AND STEPHEN SANDFORD

FARMERS' RESEARCH PROJECT

(FRP)

FARM AFRICA

P.O. Box 5746
Addis Ababa
Ethiopia

DECEMBER 1991

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PREFACE

FARM AFRICA is a non-government organisation, registered as a charity in Britain, and in 1991 working on projects in Ethiopia, Kenya and Tanzania. One of the projects it is working on in Ethiopia is the Farmers' Research Project. The chief objective of this project is to increase the capacity of non-government agencies working on agricultural projects in the North Omo region to carry out farmer-oriented research in which farmers themselves participate. Figure 1 shows the location of North Omo region in Ethiopia.

Early in the life of this project it became clear that one of the problems hindering non-government organisations both in their agricultural extension as well as in their research activities is a shortage of basic information on many of the important crops of the North Omo region. It was, therefore, decided that one of the early activities of the project should be to produce a number of technical pamphlets on important crops and other farming issues about which information is difficult to obtain from other sources.

This pamphlet on enset is the first of these technical pamphlets to be produced. Its principal author is Kefale Alemu and he was assisted by Stephen Sandford. They are both members of FARM AFRICA's staff. It is hoped that some future pamphlets in the series will also be produced by people other than FARM's staff members.

In the preparation of this pamphlet the authors were greatly helped by a number of people; including Ato Getanet Lemma, of the Ministry of Agriculture in Arba Minch; Ato Endale Taboge and Ato Mulugeta Diro, both of IAR (the Institute of Agricultural Research); the staff of the Soddo Agricultural Training Centre and of the Damota awraja agricultural office for giving us easy access to WADU publications; agricultural staff of Concern at Bedessa; and too many members of the extension service of the Ministry of Agriculture in North Omo region to acknowledge individually. We take this opportunity to express our gratitude and to acknowledge the significant contributions that they have made.

Comments on a draft of this pamphlet were received from Kelsa Kena, Mesfin Tesserra, Mulugeta Diro, Paul O'Sullivan, Seifu Gebre Mariam and Teketel Makisso. These comments were extremely useful to the authors who have made aproporiate amendments in the final version. However, the authors alone are responsible for any remaining errors and ommisions.

In addition to a thorough review of the existing literature, the principal author interviewed a large number of farmers in North Omo region either in groups or on their own. These farmers are also too numerous to acknowledge individually. As will be apparent from what follows, they should be acknowledged as the real authors and we hope that we have correctly interpreted their views.

These unstructured and semistructured interviews with farmers, together with visits paid to a number of enset plantations where the enset plants were observed and in some cases measured and counted, are referred to later in this pamphlet as "the 1991 FARM Africa survey". The farmers interviewed were selected on an ad-hoc basis, with a certain amount of purposive selection from different groups, but were not a random sample.

Enset forms an important part of the diet of about 8-10 million people in Ethiopia. The number of scientific studies made on it is very small in relation to its importance, and several of the studies which have been made are now difficult to access. It seems to us to be urgent to make the results of these previous studies and of our own work available to agricultural development workers in North Omo and in other enset regions.

There are bound to be some honest errors in what we and others have written because of the absence of enough previous work on enset and the shortage of time at our disposal. We believe that the damage caused by such errors will be small compared to the benefit conferred by making the correct information available quickly.

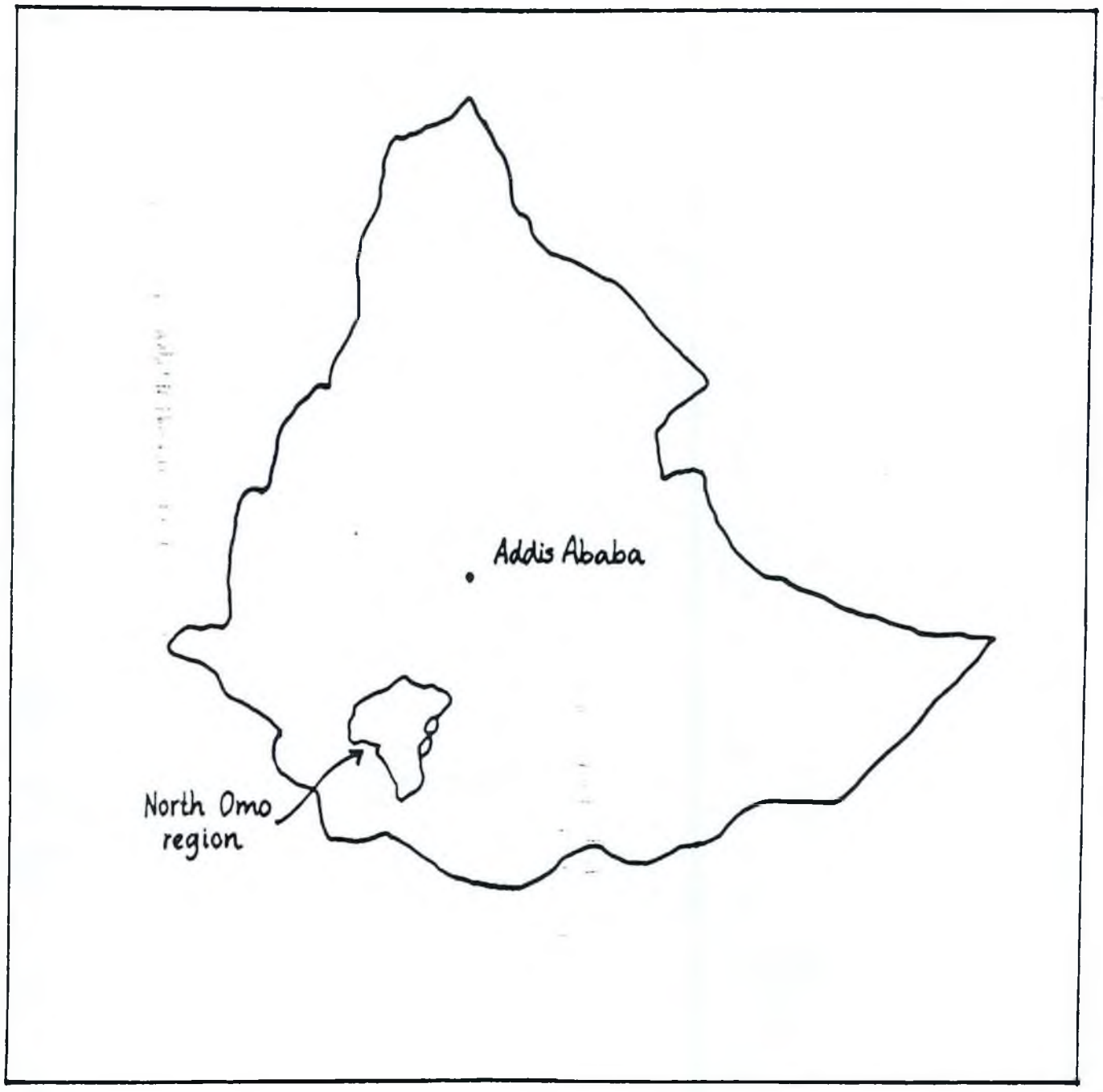
We have tried in this pamphlet faithfully to report what farmers told us, rather than to edit what we heard to fit our own preconceptions. In some cases this has caused some of our reviewers to criticise what we have written as being clearly untrue. In such cases we have altered the original wording to further reemphasise that we are reporting what we were told without necessarily endorsing it, but we have preferred not to cut out the offending passages where we are certain that we are correctly reporting what we were told.

We hope that this technical pamphlet will soon be superceded by new work with less errors. In the mean time we offer it as an interim introduction to this economically important and scientifically fascinating crop.

Kefale Alemu

Stephen Sandford

Figure 1: The location of North Omo region in Ethiopia.



CHAPTER 1: BACKGROUND

Ensete ventricosum is a large perennial herbaceous monocot plant. It belongs to the order Scitaminae, the family Musaceae, and the genus Ensete. Ensete is the scientific name and "enset" [sometimes spelt "ensat"] is the English transliteration of the Amharic name *. An older Amharic name is "Koba". Although there are eight recognised species in the genus only Ensete ventricosum and possibly Ensete edulis are economically important. Figure 2 shows the principal parts of the enset plant. Figure 3 gives a glossary of English, Amharic and Welaita (the main language of enset growers in North Omo) terms. We found considerable divergence of views about the correct terminology in Welayita. We have done our best in the face of this divergence.

In Ethiopia many different enset varieties (clones) ** are recognised by local farmers, and enset-growing households usually grow a combination of several varieties. Varieties differ in their characteristics, most obviously in the colour of their pseudostems, petioles and midribs (see Figure 2 for identification of parts of the enset plant) which may range from dark green to bronze to red, from black to yellowish green with bronze patches, etc. Varieties also differ in respect of height, circumference at base (girth), size of petiole and leaf, the tightness with which the stems cluster, and in other respects.

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* When non-English words (eg for parts of the enset plant or for its products) occur in this pamphlet such words will usually be those used by Amharic speakers, although since the enset plant is not widely grown by those whose mother tongue is Amharic, such words are usually derived from another language. When a word is used which is neither English nor the term usually used by Amharic speakers this will be indicated. The most common other language found in this pamphlet is Welaita (indicated as"Wel.")

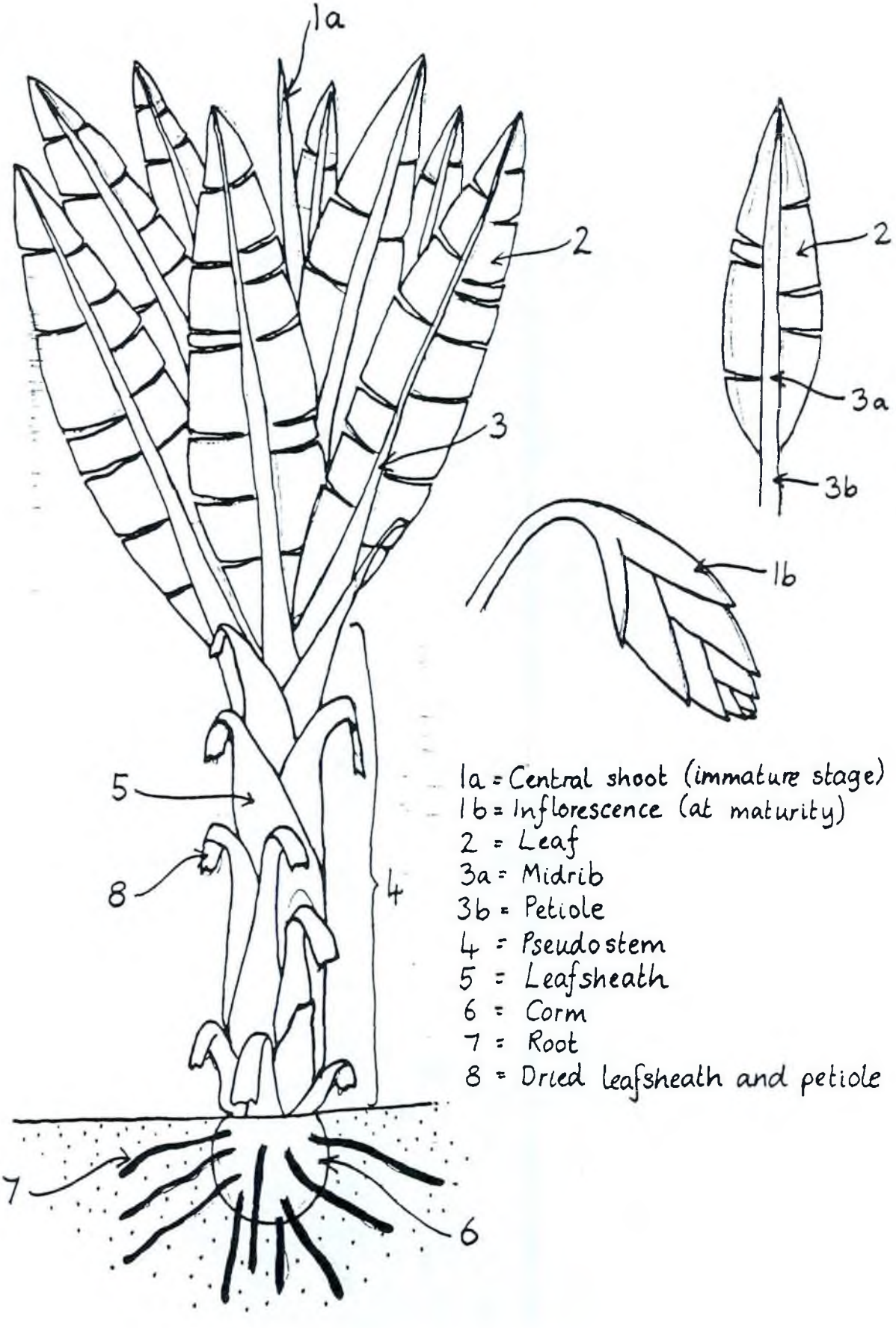
** In this pamphlet the term "variety" is used broadly rather than with particular genetic precision. Our use conforms to Daydon Jackson's (Glossary of Botanic Terms -4th edition) "Variety - a sort or modification subordinate to species".
More than one scientist reviewing this paper has pointed out that "clones" is a more appropriate scientific term than "varieties" (because enset is more usually propagated vegetatively [by transplanting of suckers] than sexually [by seed]). However the problem with the word "clones" is that very few of our readers will be acquainted with its precise meaning. We have decided to continue to use "variety" because of its greater intelligibility, but we add "(clone)" to it on the first occasion that it appears on any page to reemphasise the greater genetic uniformity arising from vegetative propagation.

Depending on variety (clone), spacing of plants, soil-fertility, altitude, rainfall, etc, individual enset plants may reach a total height (pseudostem plus leaves) at maturity (ie the age of at which the inflorescence emerges prior to flowering) of between two and ten metres and a base-circumference (measured 20 cms. above ground-level) of up to 3.5 metres.

Enset has been cultivated in Ethiopia for its food and fibre for (at least) many centuries, mainly in southern and south-western regions, particularly in south-west of Shewa, Keffa/Jimma, North Omo, Sidamo and Arssi. It also occurs, although mainly in an ornamental role, in other parts of Ethiopia including the north and east. Smeds (1955) puts its centre of origin in the lowlands between Tanzania and Uganda.

Enset is one of the main crops (in terms of its contribution to rural food supply) in a large portion of the North Omo region. According to farmers in Welaita it used to be by far their most important source of food but has lost some ground in importance to maize, sweet potatoes and taro root in recent years as the spread of bacterial wilt has made it less reliable. In Damota, Damot Gale, Damot Weyde, Gardula and Kemba awrajas it is usually planted only on land closely surrounding the owners' house, but in Sura awraja farmers also plant it, like other crops, in fields at some distance from their houses.

Figure 2: The principal parts of the enset plant.



1a = Central shoot (immature stage)
1b = Inflorescence (at maturity)
2 = Leaf
3a = Midrib
3b = Petiole
4 = Pseudostem
5 = Leafsheath
6 = Corm
7 = Root
8 = Dried leafsheath and petiole

Figure 3. A glossary of English, Welaita and Dorze terms concerning enset

ENGLISH	AMHARIC *	WELAITA	DORZE
(Pestle for pounding corm)	Aketia	Aketia	Geruma
Bacterial wilt	Atwolagi	Wol-uwa	Wol-uwa
Boiled corm	Amicho	Doysetida utta	Oatserie
Central shoot	?	Hum-uwa	
Circumference	Zuria	Yusha	Yiwusha
Clone (variety)	Ainet	Komuwa	Omo
Corm	?	Unkuwa	Oonstserie
Decorticate (scrape leaf-sheaths)	Mefak	Hasha	Asuma
Dried leaf-sheath/midrib	Woficho	Susa	Susa
Female enset	Sete	Macha utta	Macha utsa
Fermented enset scrapings	Kocho	Golla uncha	Golla hawacha
Fibre	Kacha	Golla	Golla
Fresh enset scrapings	Kocho	Golla uncha	Golla uncha
Inflorescence	Abaza	Wosa	Wosa
Leaves (enset)	Ye koba kitel	Yecha	Yecha
Male enset	Wonde	Atuma utta	Atuna utsa
Nursery (plant)	Chigign masadagiya	Besheshuwa	Bidra
Pit (eg for fermentation)	Gudguad	Olla	Holla
To pound (chop up)	Mechekchek (madkak)	Chatcha (pound) Kuta (chop)	?
Pounded corm	Workay	Godeta	Deshuntcha
Cut back or prune	Megondel (megrez)	Karafa	Kantsa
Pseudostem (leafsheath)	Ye-enset gind	Hashuntcha (Gurba= midrib)	Gurba

* Includes words of non-Amharic origin

Figure 3. A glossary of English, Welaita and Dorze terms concerning enset (Continued)

ENGLISH	AMHARIC *	WELAITA	DORZE
Rotten corm	?	Hashetia gurba	?
(Disease affecting pseudostem)	?	Woka	Oka
Decortication board	Mefakia	Oteta	Otetsa
Decortication tool	Mefakia (mefekfekia)	Mailia	Mailie
Squeeze (enset to extract moisture)	Mechimek	Gumuwa	Gumuwa
(Starchy extract)	Bulla	Itima	Itima
Suckers	Bekelt/chigign	Hata	Guso
Yeast	Irsho	Zaluma	?

* Includes words of non-Amharic origin

CHAPTER 2: DISTRIBUTION IN NORTH OMO REGION

Areas where enset is cultivated in Ethiopia tend to be among the most densely populated by humans. These areas also tend to be situated above 1500 metres above sea level. North Omo follows the general pattern of enset-growing areas in Ethiopia. Taye et al (1967) and Westphal (1975) considered the altitude range between 1700 and 2000 metres above sea level, with a mean daily temperature range from 18-20 degrees C and a relative humidity range from 60-80%, to be the best for enset, although enset also grows well at altitudes in excess of 2,000 metres. Enset does not grow so well at very high altitudes (more than 2,800 metres a.s.l.) where low temperatures slow the rate of growth (although, according to North Omo farmers, final plant size and food yield at very late maturity [allegedly up to 20 years although this seems improbable] can be high).

Enset also does not grow well at low altitudes, ie below 1500 metres a.s.l. In the case of low altitude poor performance may be due to high temperature, although the exceptionally good performance (in terms of high growth rate and plant size) of one small irrigated enset plantation seen at an altitude of 1200 metres suggests that poor performance at low altitudes may have more to do with moisture stress than with high temperature as such. Enset plants can survive short periods of drought but do not do well under conditions of chronic moisture shortage.

The following data, presented in Table 1 and drawn from a non-random selection of four plants from two varieties grown at two different altitudes, show the sort of analysis which it would be desirable for a proper survey to undertake to explore the relationships between altitude and variety (clone) and age of plant.

Table 1: The relations between altitude, variety, age of enset plant and some growth characteristics

Altitude (m.a.s.l.)	Variety	Age (years)	Height of leaf (m.)	Height of pseudostem (m.)	Circumference (m.)
2500	Ketisha	8	5.35	3.50	2.27
2500	Messa	6	4.15	2.30	2.58
2800	Ketisha	7	5.22	2.82	2.39
2800	Messa	7	4.25	2.35	2.64

Enset grows best on well-drained soils that are rich in organic matter, and that are in the PH range 5-7. Farmers believe that enset prefers black soils.

Table 2 shows the distribution of total land, human population and enset cultivation between the 18 awrajas of North Omo region. The figures for land under enset cultivation are derived from fairly subjective estimates (rather than precise measurement even on a sample basis) made by junior staff of the Ministry of Agri-

culture. We have considerable doubts about the reliability of these data on enset cultivation. For example the data for Bankameskato are, we suspect, exaggerated, and those for Gardula severely under-estimated. However they are the only data at present available so we include them, but with a warning. With the data available there is a negative correlation between human population density and the area of cultivated enset per head.

Table 2: Land area, population and enset cultivation in North Omo region

Awraja	Total land area km^2	Total human popul-ation (000) *	Human popul-ation density #/km^2	Land under enset culti-vation (ha)	Enset culti-vation as % of total land	Enset culti-vation per person (m^2)
Arba Minch Zuria	1962	134	68	450	0.23	34
Bankameskato	2382	145	61	7081	2.97	488
Boloso Sore	629	260	413	1200	1.91	46
Damota	1790	307	172	2532	1.41	82
Damot Gale	418	217	519	252	0.60	12
Damot Weide	748	149	199	250	0.33	16
Ella	2171	61	28	95	0.04	16
Gardula	3042	94	31	30	0.01	3
Kemba	2109	193	92	480	0.23	25
Konso	1034	191	185	0	0	0
Koisha (Kullo)	2620	174	66	1564	0.60	90
Kindo Koisha	1735	99	57	1652	0.95	167
Mazee	2495	123	49	796	0.32	65
Mensa	1738	87	50	?	?	?
Satusa	1422	89	63	500	0.35	56
Sura	700	85	121	2000	2.86	235
Ubamazie	1720	163	95	2164	1.26	133
Zenti	1750	145	83	12	0.01	1
TOTAL	30465	2716	89	21058	0.69	78

Source: North Omo regional agricultural office files
= Number
* The raw data came from urban kebeles and peasants' associations and refer to about 1988 GC.

CHAPTER 3: USES

Enset is a multi-purpose crop, all parts of the plant except the fibrous roots having some economic importance.

Food, food-related uses and livestock feed

The corm, the pseudostem and the stalk of the inflorescence are the most important sources of food.

There are four products of the enset plant normally eaten by humans:-

1. Kocho (Wel. uncha) is the decorticated (scraped-off) mass (the technical term is mesophyl) of the leaf sheaths which collectively make up the pseudostem of the enset plant. To this decorticated mesophyl from the pseudostem there will also often be added part of the pounded up corm and the chopped-up inflorescence stalk (see also under "workay" below). Together these are all known as "kocho" (for the Welaita term see under workay below. This kocho is put into a pit (Wel. olla), a yeast-like substance (see below) is added, and the mixture is fermented for 15-30 days. It is then squeezed, drained and chopped finely to make a dough-like substance ("refined kocho") from which bread is made. This bread is also called kocho (Amh.)
2. Bulla (Wel. itima) is the paste or powder formed, after precipitation and dehydration, from liquid which was drained off (pre-fermentation) from kocho and from the stalk of the inflorescence.
3. Workay (Wel. godeta) is the part of the corm which has been pounded up by the aketia (a sort of pestle with teeth on its tip). Workay is also made from the chopped up stalk of the inflorescence (there is a divergence of expert opinion about the importance of this source). The pounded up corm may be, during processing , mixed with the scrapings of the pseudostem to make fermented and processed kocho, or it may be processed and eaten separately, after fermentation in a pit, as workay (godeta). It is possible that in Welaita a higher proportion (than in other enset regions) of the corm is consumed as godeta and a lower proportion is added to the kocho. When the pounded corm is added to the pseudostem scrapings the combined kocho is known as "Shocha uncha" (Wel.) in Welaita. N.B. The term "workay" is also sometimes used of enset as a whole and not just of the pounded corm.
4. Amicho (Wel. doysetida utta) is the boiled up corm which has not been pounded but has been cut up into large chunks. Amicho is usually made from immature and not from mature enset. However sometimes the inner soft part of the mature plant is also used for boiling.

In addition to these four important main products, a fermentation-enhancing yeast-like substance (Wel. zaluma) is made from some of the pounded up corm or decorticated pseudostem mixed together with onions, other herbs, chopped-up young enset and bananas. The fermentation process of this zaluma (yeast) is started separately in the hollowed-out shell of the corm. After

about a week of separate fermentation this zaluma (yeast) is added to the separate pits (Wel. olla) where the kocho (Wel. golla uncha) and workay (Wel. godeta) are waiting for it.

A further use in human food is that the fresh leaves (Wel. yecha) are often used for wrapping bread while it is being baked.
Especially during the dry season the domestic livestock in the dega and weina dega agro-ecological zones are substantially dependent on parts of the enset not normally eaten by humans but which are discarded during harvesting and cutting back; and in particular the upper parts of the leaf sheaths composing the pseudostem, the leaf, the petiole and the soft inner part of the central shoot. Sometimes immature enset plants are harvested primarily as a source of livestock feed.

Nutritional values

Local people in North Omo believe that enset products are inadequate to provide a proper diet if fed without any other supplements over a long period. In particular they cite general weakness and susceptibility to diseases as consequences of excessive reliance on enset. It is believed that normally enset-growers also keep domestic livestock (which also feed on enset) and are able to supplement the enset diet of humans with animal products, and in particular with milk, as well as with the other crops (eg haricot beans) which they grow. However reliable statistical data are not available about the proportion of enset-growing households who also own domestic livestock.

Tables 3 to 5 set out the results of a number of laboratory tests of the value of food products derived from enset.

Table 3: The nutrient content of Kocho per 100 grams

Moisture content	45%	Thiamine	0.018 mg
Calories*	190	Riboflavin	0.5 mg
Protein	1.45 gm	Niacin	0.2 mg
Fat	0.25 gm	Ascorbic acid	0
Carbohydrate	45.40 gm		
Calcium	142 mg		
Iron	4.9 mg		

Source: Berry 1959

* The original document says "Calories". We assume kilo-calories (Kcals) are meant.

Table 4: The protein content of Kocho (as a % of dry weight) by variety and length of fermentation

Variety (clone)	Length of fermentation period (in months)			
	Fresh	1.0	4.5	5.5
Sebera	6.25	4.65	4.44	4.09
Kuena	6.25	4.50	3.97	3.81
Lakaka	1.88	2.44	2.97	2.75
Geshera	1.72	1.69	1.88	2.25

Source: Gebremariam 1984, quoting Besrat et al 1977, a paper entitled "Effect of variety differences and fermentation on protein quantity and quality of enset".

Table 5: Nutrient contents of different enset products (in terms of weight per 100 grams)

Nutrient	Enset product	
	Kocho	Bulla
Carbohydrate	41.3 %	55.4 %
Water	51.3 %	43.7 %
Protein	1.25%	0.25%
Fat	0.2 %	0.1 %
Calcium	120 mg	44 mg
Iron	5.3 mg	7.7 mg

Source: Ethiopian Nutrition Survey 1958

As can be seen in these tables enset is low in all nutritional values except carbohydrates. It is particularly low in protein (although the figures of 1.45% in Table 3 and 1.25% in Table 5 above may be atypically low [Teketel Makisso pers. com.]), but there is some evidence that it is relatively high in some amino-acids, eg lysine, but low in others, eg methionine. However overall, given the prevalence of other low-protein root and tuber crops in North Omo, the management of the calorie/protein balance in the human diet must present particular problems to North Omo households.

Storability of enset food

The views of local people tend to vary widely on the subject of the length of time for which enset food products can be stored. Among the various enset food products, only the corm can be boiled and eaten immediately after harvesting. The main product of enset is kocho. The scrapings from the leafsheaths of the pseudostem and some of the pounded up corm must be put into a pit and fermented for between 15 and 30 days. Thereafter it can be consumed as kocho.

However, it does not have to be consumed immediately. In Damota, Damot Gale,and Damot Weyde awrajas farmers claim that if a mature enset is scraped and the kocho stored in a well prepared pit it can be kept for up to eight years without being spoilt. Some farmers go further and state that the product actually improves over time.

A well prepared pit is one in which enset leaves are carefully spread on the floor and round the walls, and, after the scrapings are put in the pit, over the top as a cover as well. This is done in such a way as to exclude water and air, and possibly to maintain an even temperature. For very long periods of storage, it may be necessary to shift the material from one pit to another so that this surrounding enset leaf covering can be renewed. For long term storage the pit may actually be inside the house.

However farmers in other areas did not believe that kocho could be stored for so long and claimed that the product tends to deteriorate over time. However there was general agreement that enset products can not be stored for as long in lowland areas (ie around and below 1500 metres a.s.l.) as at higher altitudes.

Some farmers claim that bulla can be stored for as long as kocho can, although it seems improbable that in practice anyone does so with this high value product, which in any case requires very careful avoidance of air and sunlight if it is to keep well.

Fibre use

The fibre (Wel. golla) from enset is used to make rope and twine, and it is also used in the weaving of products such as shopping bags, hand bags, suitcases, sieves, pouches and mats. The variety, the age of the plant, and the way in which the fibre is extracted and stored all determine its length and quality.

The length of the leafsheath as made ready for scraping, rather than the total height of the parent plant, largely determines the length of fibre. For example it was observed in Damot Gale awraja that, although the height of the edible part of the leafsheaths (Wel. hashuntcha) that form the pseudostem ranged from 1.2 to 3.4 metres, the normal length of the scraping board (Wel. oteta), on which the carbo-hydrate material that will become kocho is scraped from the leafsheaths, is only 1.4 metres. Hence if the leafsheath to be scraped is longer than 1.4 metres it will be cut into two or more parts so as to match it to the length of the scraping board; and the length of fibre is accordingly also reduced for the same reason.

The strength of enset fibre in comparison with other fibres lies towards the middle of the range as Table 6 indicates. However the figures for enset in Table 6 are the average of fibres from a number of varieties (clones) and parts of the plant and there is considerable variation between enset fibres.

Table 6: A comparison of the strength of fibres from different plants

Parent material	Strength (gms per denier)
Abaca	7.0
Sisal	4.4
Enset	5.0
Henequen	3.3
Sanseviera	4.5

Source: Godfrey et al. 1985; Demeke, 1985; both quoting Debre Zeit Agricultural Research Station 1975-76.

Medicinal uses

Local people in North Omo credit enset, or varieties (clones) or parts thereof, with a number of different medicinal properties. The varieties listed below are those believed to have the greatest medicinal importance:

- Swetia
- Wassa ifia
- Boliae
- Tasso
- Lochingie (Loluwayia in Kemba)
- Gefetenuwa

Among the important medicinal properties they are believed to have (we do not endorse these beliefs we simply report them) are the following:

1. If a woman eats bulla, together with milk and milk products, after giving birth she regains her strength and recovers much quicker.
2. If someone takes kosso (medicine against tape worm) then subsequently eating bulla from the Boliae variety will protect him/her from any bad effects of taking kosso.
3. People with stomach ulcers can eat enset products without any problems.
4. Eating some varieties, eg especially Tasso and Wassa-ife, assists those with broken bones to heal faster and better.
5. Eating the variety Lochingie helps those who take traditional local medicines against diseases of the liver to avoid the bad effects of these medicines.
6. Some varieties assist in birth control, eg by preventing conception. Lochingie is said to be used for birth control.
7. Eating enset products can help in the cure of cholera or other forms of diarrhea.

Other uses of enset

Enset is also used, particularly dried leafsheaths (Wel. susa), as packing and wrapping material, in fencing and in house construction.

Male and female enset

Farmers in North Omo tend to put enset plants into two categories, "male" and "female" (Wel. atuma and macha respectively).

This distinction has nothing to do with the method of reproduction but is according to other morphological and biological characteristics. Usually all the enset plants within a particular variety (as classified by farmers) are put into a single "sex" category, ie a variety is either "male" or "female". However some varieties which display mainly "male" characteristics also display some "female" characteristics. It is alleged that a higher proportion of enset plants are "male" in highland than in lowland areas and that men prefer "male" and women prefer "female" plants.

Table 7 sets out in some detail the perceived differences between "male" and "female" enset. In summary "female" enset are seen as early maturing, more palatable (sweet or tasty in some other way especially when the corm is boiled), more easily scraped, less fibrous and generally delicious. In contrast the "male" is less palatable, less easily scraped and more fibrous and when the corm is boiled it becomes glutinous and rather soggy.

Table 7: The perceived differences between "male" and "female" enset.

Criterion	SEX CATEGORY "Male"	"Female"
Maturity	Late maturing	Early maturing
Fibrosity	Strong, high quality	Low strength/quality
Size	Big	Smaller
Susceptibility to diseases and pests	Resistant	Susceptible
Corm	Fibrous/unpalatable	Delicious, low fibre
Kocho	Ferments slowly	Easily fermentable
Leaves	Hard and stiff	Soft
Susa*	Hard and stiff	Soft, fragile

Source: FARM Africa 1991 survey
* Susa is the Welaita word for a semi-dry petiole or leaf sheath (see Figure 2) which is used for wrapping and packing, for house construction and fencing.

One reason (alleged by men) for preferring "male" enset is because there is less temptation for the women to harvest the plant before maturity for the sake of eating the delicious boiled corm of the "female" plant. The proportion of the pseudostem that can be used for kocho rises at maturity, and so overall there is a net gain, in terms of calories harvested per unit of time the plant is in the field, if it is left to maturity. The men's view is that they are far-sighted enough to recognise this whereas women are not, and can not resist the temptation to harvest "female" plants before maturity; and so (argue the men) its better to grow "male" plants which do not give rise to the same temptation.

However, there is some evidence from the age structure (see later in this pamphlet) that there is a deliberate management of the enset plantations so that a number of plants are from the outset intended to be harvested prematurely, mainly for the use of their corm as human feed. It seems logical that these plants should be female, and farmers consistently claim that this is so. However in our quantified work on age structure we did not collect information also on "sex", so that quantified evidence on this point is not yet available.

CHAPTER 4: EXISTING PRODUCTION SYSTEMS

Introduction

Enset production and processing systems vary from one part of North Omo to another. In what follows on production systems we have identified some of these variations whereas others have gone unnoticed and need to be identified by subsequent studies.

Varieties (clones)

As mentioned earlier, North Omo enset-farmers usually each grow a number of different varieties (Wel. komuwa) of enset. The adaptability of different varieties to different agro-ecological and economic environments is not yet well understood. Table 8 below lists, by awrajas and by local names of varieties, the present distribution of varieties (as named by local farmers) across the awrajas covered by the FARM Africa rapid survey in mid-1991. It is a preliminary effort which needs to be supplemented by a more intense effort to relate particular varieties to the ecological zones within awrajas.

The list is probably not quite complete, in the sense that farmers forgot to mention some varieties grown in their awraja. As can be seen in Table 8 about one hundred different "varieties" (names) are listed. Their frequency of appearance in the lists of the surveyed awrajas is as follows:-

	Number of varieties (clones)
In all 6 awrajas	0
In 5 awrajas	3
In 4 awrajas	5
In 3 awrajas	19
In 2 awrajas	12
In only 1 awraja	60
TOTAL	99

It is at least possible, and may be probable, that these are not distinct varieties, ie are not significantly different genetically, but merely represent a list of local names, and many of the names represent cultivars which are not genetically distinct. As can be seen there is greater "sharing" of varieties within the three northern (Welaita) awrajas and within the two southern awrajas of Kemba and Sura (ie within the left hand 3 columns and the next two columns) than there is between these groups. This may reflect linguistic and cultural homogeneity, or it may reflect the fact that the southern awrajas have a higher proportion of dega zone under enset planting. However the third southern awraja of Gardula, where the language is not related to those in the other two southern awrajas, has a completely different set of enset names (varieties).

Table 8. The distribution of enset varieties (clones) in North Omo region by awraja

Varieties (clones)	AWRAJAS					
	Damota	Damot W	Damot G	Kemba	Sura	Gardula
Ado		X				
Adununa		X				
Aginia		X				
Akalsongie				X		
Akatsunkie				X		
Alagena		X				
Anko	X					
Ankogena	X	X	X			
Argema	X		X			
Arkie	X	X	X			
Bango				X		
Bedadia		X	X	X		
Boda				X	X	
Boliae		X				
Bonna-azo				X		
Borra	X					
Buduntua	X					
Bulua	X	X	X			
Bundo				X		
Burena						X
Checho					X	
Chemishe				X		
Chemo					X	
Chichia	X	X				
Dako		X				
Derbo		X				
Delulia	X		X			
Dogiata						X
Dokezie					X	
Dorkie				X		
Edo				X		
Erota						X
Gashikie				X		
Gefetenuwa	X	X	X			
Gena	X	X	X	X		
Genebuwa	X	X	X			
Genessa	X	X				
Gessierie				X	X	
Godere	X	X				
Haleko				X		
Halkebita						X
Hal-a	X	X	X			
Hambaro				X		
Herigie				X		
Hodoro				X		
Hoie				X		
Keberi	X	X	X			
Kekero	X	X				
Ketene	X	X			X	
Ketishe	X	X	X	X		

Varieties (clones)	AWRAJAS					
	Damota	Damot W	Damot G	Kemba	Sura	Gardula
Kirro				X		
Kocha			X	X		
Kongola						X
Kortso				X		
Kuane	X	X	X			
Kuoe		X				
Lembo	X	X				
Lochingie	X	X	X			
Lo-offo					X	
Mahia			X			
Mala				X		
Mandulka	X					
Matia	X	X	X			
Mello				X		
Messa				X		
Mazia	X	X	X	X	X	
Moche	X		X			
Mosse	X	X	X			
Mula-la						X
Nakaka	X	X	X			
Okeshia	X	X				
Oha	X	X				
Orgazo					X	
Pena		X				
Phalakia	X	X	X	X	X	
Phello	X	X	X	X	X	
Pheluma		X				
Phosho				X		
Pungara		X				
Puressa		X				
Senka	X	X				
Sessa				X		
Shelekumia	X	X	X			
Siniota						X
Sinkatia				X		
Siraria			X		X	
Sompee				X		
Sorgie				X		
Sweetie	X	X	X	X		
Tasua			X			
Tsewesa				X		
Tsitsate				X		
Tuzuma	X	X	X			
Wandie	X	X	X			
Wossa-aife					X	
Yamie	X					
Zinkate	X	X	X	X		
Zinkia	X	X	X		X	
Zutuma	X					

Source: FARM Africa 1991 survey

Propagation

In all areas surveyed, except in the highland part of Gardula district, the propagation of enset is done by vegetative methods. In the highland part of Gardula propagation is done both vegetatively and by seed, although the seedlings observed seemed to be less vigourous than the sucker-derived plants obtained from vegetative propagation.

Vegetative propagation is done by use of suckers that sprout from the corm of the plant after it has been buried subsequent to uprooting (see below). It is said that mature enset will not produce suckers in this way and that only immature (ie plants in a state prior to the emergence of the inflorescence stalk) can be used for vegetative propagation.

There are three slightly different methods of vegetative reproduction used in North Omo region:-

1. After an immature enset is uprooted, the pseudostem is cut off from the corm about 10 cms above where the pseudostem and the corm join. The corm is then split (vertically) into two or four equal parts, each of which will be buried in a separate patch of well-prepared and manured soil.
2. Without uprooting the plant, the pseudostem is cut off about 10 centimetres above the join of the pseudostem to the corm. The corm is then split vertically into two or four equal parts and left where it is. Only after suckers appear is the corm uprooted and then slightly covered (but not fully buried) in a different place, or places if the four parts are separated at this time.
3. After the enset plant is uprooted and the pseudostem is cut off at the usual height, the entire corm, without splitting, is reburied in a fresh hole. However, in this method in order to give a chance for multiple suckering the place where the central shoot (Wel. hum-uwa) joined the corm has to be bored out, otherwise the corm will only produce one shoot from where the central shoot used to grow (due to apical dominance).

The first method is the most common in Damota, Damot Gale, Damot Weyde, Kemba and Sura awrajas, while the second method is predominant in the highland areas of Gardula. The third method is the rarest.

Transplanting

Whatever the method for propagating suckers, the suckers are separated from the corm after about a year of growth. They are then usually transplanted into a well prepared and manured nursery site (Wel. besheshuwa) generally a little beyond (ie further from the homestead) where the households more mature enset are growing, in order to escape unequal competition with them. At this point the transplanted suckers may be spaced as close as 20 centimetres to each other if there is not enough planting space.

Thereafter the young plants may be transplanted a further one or two times, depending on the scarcity of land and the availability of vacant sites in the more mature plantation as mature plants are harvested.

At each transplanting the roots are trimmed and the leaves and stalks are cut back (Wel. karafa) to a little above the point at which they separate from their pseudostem. Farmers give the following reasons for this severe cutting back:

1. It reduces the area of the plant exposed to the wind, and therefore reduces disturbance which might be caused by the wind until the roots are established.
2. Severe cutting back stimulates very fast leaf regrowth.
3. It more evenly distributes sun, rain, and air between the different plants in a nursery site.
4. The cut-back material is a valuable livestock feed and is not necessary for plant growth or survival.

Intercropping

Some intercropping of other crops with enset occurs while the enset crop is still young, ie up to two years after suckering. Thereafter the height of the enset plant and the spread of its leaves lead to an excessive shading effect on most intercrops although there is some evidence of a beneficial effect on coffee. The same would occur the other way round if an attempt was made to grow young enset amongst mature coffee or sugar cane.

Intercropping of maize, Ethiopian cabbage and some of the root crops (eg taro, Oromo potato, amoch (Amh.;possibly this is Arisaema)) with young enset occurs. However some farmers believe that intercropping with haricot beans and Irish potatoes is not advisable as the haricot beans climb up and tend to strangle the enset *, while harvesting Irish potatos may damage the root system of the enset. Patches of sweet potato, usually that which is going to be used as new planting material, are sometimes found intercropped with enset

Labour and other input requirements for enset production

The most difficult work in enset production (excluding processing) is the preparation of the ground, particularly when new land is brought under enset cultivation. The soil must be dug down to a depth of 35-40 centimetres, and this is done manually using traditional tools. After the ground has been well dug manure is spread on it.

During the early stages of the enset plant's life considerable maintenance work has to be done in addition to that required for transplanting. The ground must be weeded, old leaves removed from the plant (not all farmers believe in doing this), and in some areas, eg Kemba and Sura, the leaves of young enset plants are tied round so that they bunch up together rather than drooping outwards. Farmers explain this practice in terms of preventing one plant shading another, of keeping the air circulating between plants, and generally of enhancing more rapid growth.

* It is not clear whether this applies to haricot beans in general or to particular climbing varieties.

When the plant reaches its third year of life (from first suckering) the maintenance requirements decrease. This is because by this stage the enset, with its well established root system and strong wide leaves, dominates and overshadows the surrounding weeds which can no longer compete.

Manure

Adequate farm manure is regarded as essential to successful enset-growing, and it was observed during the FARM Africa survey that farmers with unproductive-looking enset plantations were those farmers who had fewest livestock.

Cattle in many parts of North Omo are kept for a large part of their time indoors in a special section of the farm house. Often a special hole is made at ground level through the wall of this section to allow livestock urine and manure to flow out of the house by gravity into the enset plantation.

Harvesting

Farmers agree that the proper time for harvesting enset is when it produces an inflorescence at maturity, and that if it is left for long after this the quality and yield rapidly decline. However, some of the farmers in the highlands of Gardula awraja believe that if the stalk of the inflorescence (Wel. wosa) is cut down before flowering time then harvesting can be delayed for several further months without ill effects. However if they do this they will no longer get so much bulla from the plant although the kocho yield will be increased.

Farmers say that the best harvesting months are Nehassie, Hidar and Tahsas and the quality of the product will be highest for enset harvested at that time. However a number of constraints, such as the need for enset products at the Meskel festival in Meskerem, or shortage of food or labour, may prevent harvesting at the optimum time.

The enset plant apears to store the maximum amount of food in its pseudostem, its corm and in its inflorescence stalk at the time the inflorescence emerges. If harvesting is delayed thereafter until the seeds ripen there will be a sharp decline in yield particularly in the amount of bulla (Wel. itima) extracted.

When the leafsheaths (Wel. hashuntcha) of the pseudostem are separated from the corm at harvesting time, they are placed piece by piece on the scraping board (Wel. oteta), which is often leant at an angle of more than 60 degrees against another enset plant. The stripped off leafsheaths are placed or hung on the scraping board and scraped with a device made of bamboo (Wel. mailia), and the scraped-off mass will then be put, as already stated earlier, in a pit for fermentation.

Production and Yield

There is a lack of good data on enset production and yield. There are a number of reasons for this. One is the long life-span of the enset plant combined with the number of times which it is transplanted, giving rise to the difficulty of expressing enset yield in comparable terms (eg kgs. of product per hectare per year) with other crops. Another reason is that one cannot sample the yield on less than one complete plant which is a relatively high proportion of a peasant farmer's total annual production. A third reason is that the plant does not come to maturity (or the farmer may not wish it to be harvested) at a particular season of the year and the main product, kocho, takes 15-30 days after harvesting before it achieves the edible (and effectively measurable) form. This makes the organisation of normal sample survey harvesting techniques for measuring yield extremely difficult to apply.

One very important reason for the lack of good yield data is the fact that from a single mature enset plant several different human food products (as well as animal feed and fibre) are harvested, ie kocho, bulla and workay. Some of the published reports on enset yield refer only to the yield of "kocho", without making clear whether this includes, in addition to the scraped leaf-sheaths of the pseudostem, the yield of bulla (starch extract) and of pounded corm. Farmers' opinions around Soddo are that ratios between the yields of kocho/bulla/workay in mature enset are in the region of 70/6/24. However work by IAR (Holetta 1972/73, p.314) suggests that the pre-fermentation weights of scraped pseudostem and pounded corm may be about equal. It is not clear whether or not this difference in ratios arises because of differences in the way in which pounded corm is processed, ie the extent to which it is fermented and eaten separately as godeta (Wel.) or added to the scraped pseudostem to be eaten as shocha uncha (Wel.).

There is a further problem. The yields quoted in the published reports assume that enset is always harvested at maturity. As already mentioned, and as will be discussed again later, about 70% of all enset planted out from suckers do not reach the age of four years, ie they "disappear" prior to maturity. There is no information at present available to tell us what proportion of these "disappearances" are due to:- (i) mortality and wastage; (ii) sales of the plants as "seedlings" to other farmers; or (iii) consumption of the corms by humans and of the above ground biomass by livestock. The consumption (iii) and sales (ii) should be included in calculations of economic yield; the mortality and wastage (i) should not.

There is yet another difficulty. Often yields of enset are expressed in kilogrammes of "kocho". But the word "kocho" can be used of the material at several different stages of processing (including fermentation), ie (i) of the scraped raw material prior to fermentation; (ii) of the immediate post-fermentation mass prior to squeezing out excess moisture; (iii) of the refined but uncooked material: (iv) of the bread-like cooked material made from (iii). Although yields are unlikely in to be expressed

in terms of the cooked material(ie iv), and the expression "kocho" is less often used of the pre-fermentation raw material, ie (i) , it is usually not at all clear whether a yield on a particular occasion is expressed in terms of stage (ii) or (iii). But as Table 9 below shows, the processed material can lose betwen 25 and 60% of its weight between these two phases as a result of moisture and other losses. However, rather surprisingly, a food composition table (Agren and Gibsen 1968) for Ethiopia shows only a decline from 54% to 50% to 48% as kocho progresses from the fermented through the unbaked flour to the baked stages; although this seems improbable.

What follows is, therefore, a composite picture built up from different sources and based on a number of assumptions:-

a) Yield of edible food (kocho, bulla and edible corm including workay) per harvested mature enset plant is in the range 20 to 40 kilogrammes (see, for example, Tables 9 and 18-21 below). This we assume to be post-fermentation post-squeezing "refined" kocho.
b) This (post-fermentation) refined kocho has an average moisture content of 50% (see Tables 3-5 above).
c) The energy content of this refined kocho is about 1.9 Kcals (kilo-calories) per gram (see Table 3 above). Compare this to grain at about 3.2 - 3.6 Kcals per gram, but a gram of grain only has a moisture content of about 12% compared to the 50% for enset food. So, per gram of dry matter, enset has about the same number of calories as a gram of grain dry matter.
d) It normally takes about 4-7 years (eg at an altitude of 1900 metres) for an enset plant to reach maturity after splitting off the sucker from the mother corm from which the sucker derives.
e) During these 4-7 years the enset plant spends about 60% of its time at a spacing equivalent to 6.25 square metres per plant (2.5 metre spacing from plant-centre to plant-centre) and 40% in a nursery stage with a spacing equivalent of only 1.55 square metres per plant (1.25 metre spacing). These are very rough figures based on measurements done in 1991 in Welaita in respect of only 20-30 plants. So the weighted average space required per plant over its life time is about 4.35 square metres, ie 2300 plants per hectare.

From the above we can conclude that the average yield of enset per hectare <u>per year</u> is as follows:

a) Food (post-fermentation post-squeezing refined kocho at 50% moisture content): 66 to 230 quintals;[ie 20 (kilograms per plant) X 2300/7 (plants-per-hectare/years-to-maturity) to 40 X 2300/4]
b) Dry matter: 33 to 115 quintals; [ie half of figures at (a)]
c) Energy equivalent: 39 to 137 quintals of grain.[ie 66 X 1.9/3.2 to 230 X 1.9/3.2]

Excluded from the above calculations are both the food content of the enset harvested and eaten before it reaches maturity <u>and</u> the land occupied by enset that is eaten or otherwise destroyed before it reaches maturity. We lack data on both these parame-

ters. The amount of enset eaten before maturity is important in Sura awraja, according to farmers there, but may be less important in the Welaita area.

The conclusion is that enset production yields about 1.3 - 3.5 times as much food energy per hectare per year as does maize grown under peasant conditions in Ethiopia, assuming a peasant maize yield of 30 quintals per hectare on land as well prepared and manured as enset land normally is. This high yield of maize is compatible with the results of the national fertiliser trials (ADD/NFIU, 1991, Tables 9a, 9b, and 11).

As can be seen there is an excessive amount of scope for error and guesswork in these calculations; and there is a consequent urgent need and scope for research on these issues. Clearly there are going to be large differences between agro-ecological zones, but our data at present are so weak that it is not worth even guessing the magnitude of these.

We can run a check on these calculations. Acording to WADU (1979/1980) 40-69 mature enset plants are required to provide an adequate feed intake for a year for a family of 5-6 persons. The proportion of the total feed intake of the family provided by enset is not mentioned in this report. In the FARM Africa 1991 survey farmers in Sura awraja suggested that for an average family that gets 50% of its food intake from enset, some 12 -20 (say 18) mature plants are required per year. This is roughly compatible with the view expressed to us by farmers at Buge in Damot Gale awraja that a mature enset plant will provide food for a family of 4-5 people for about 20 days.

If the average yield of kocho, bulla and workay (Wel.Godeta) per mature plant is 30kgs, this is equivalent to a total family calorie intake from enset of 1,080,000 Kcals per year (ie 18 X 30 X 2000) [2,000 rather than 1900 Kcals per kg because we are including higher-energy bulla as well as kocho]. The average size of family in the enset producing areas of North Omo may be about 4.5 persons (1984 Population and housing Census, average for Sidamo [which included Welayita] and Gemu Goffa) although the relief agency Concern found an average household size of 5.9 persons in Damot Weyde awraja (Paul O'Sullivan pers. com.). This suggests that the 50% of its food that it allegedly gets from enset (ie if it consumes 18 mature enset plants per household per year) gives the North Omo enset growing population about 660 Kcals per person per day (ie the full diet of enset plus other foods gives it 1320 Kcals per person per day).

This figure (1320 Kcals per person per day) is very low, compared to an estimated "calorie requirement" of 2000 Kcals per person per day or to an estimated nation-wide actual supply in recent years of about 1800 Kcals (IFPRI 1991). However the figure is only about 25% short of a plausible, say, 1700 Kcals, given the experience of recent years that the Welaita human population is constantly bordering on starvation. Moreover additional survey data available to FARM Africa from the Welaita area suggests that

most families no longer get as much as 50% of their food intake from enset products (see the end of Chapter 6 below).

Regional differences in yield

There is no quantitative data on differences in yield (however yield may be defined) between different parts of North Omo. Such differences may well be large. Table 9 below reproduces data on some differences in the performance of enset plants in different parts of southern Ethiopia. Note, in Table 9, how the yield of raw material, both before and after processing, varies much more between regions than the yield of refined food.

Table 9. The yield of food **** per plant of mature 8-year-old enset from three parts of Ethiopia

Part of Ethiopia	Weight (kgs) per plant of raw material processed for food		Weight of refined food (kocho)**** per plant	
	Before fermentation	After fermentation	Kgs	As % of post-fermentation wt.
Endibir*	89	40	30	75
Kambata**	130	54	34	63
Sidamo***	111	73	27	37

Source: Teketel 1975
* Averages from 93 plants
** Averages from 50 plants
*** Averages from 35 plants
**** Includes pounded corm as well as bulla and scraped pseudostem.

Processing

This pamphlet does not deal, except to a very slight extent in Chapters 3 and 7, with post-harvest processing of enset. It is hoped to fill this gap in a separate paper.

CHAPTER 5: CONSTRAINTS IN THE EXISTING PRODUCTION SYSTEMS

The principal agronomic constraints to enset production are disease, pests (both insects and wildlife), shortages of labour and land, villagisation, the age structure of plantations, and climate. Each of these is discussed below.

Diseases

Enset is susceptible to several diseases, but the most widespread and destructive of these appears to be bacterial wilt. An account of this disease is given by Dereje (1985) who found that the efficiency of transmission of the disease was highest, out of several pathways investigated, when petioles were cut with infested knives. Eshetu (1981) attributed the transmission of wilt pathogens to three insects. At present the awraja in North Omo with the heaviest present incidence of the disease is Gardula, but it is a disease which seems to come in waves, ie periods of high interspersed with periods of low incidence of the disease, and other awrajas may have had as heavy an incidence in the past, to the extent that in some parts farmers have had to switch to other crops whereby to reduce their previous heavy dependence on enset.

Several other diseases affecting enset have also been identified by pathologists of the Institute of Agricultural Research (IAR) and of other organisations. Among these were: *Septoria spp; Cylindroclaudium quingeseptatum; Thielaviopsis spp; Phoma spp.* These observations were confirmed by the Commonwealth Mycological Institute.

There follows here an account of various diseases described by farmers. The distinctions between different diseases as described by farmers may not coincide with the distinctions made by scientists, eg one farmer-specified disease may include two or more scientist-specified ones. Similarly one scientist-specified one may include two or more farmer-specified ones.

The farmers' description of the disease identified by scientists as bacterial wilt is a follows. First, leaves other than the central shoot turn yellowish in colour, and subsequently the whole plant wilts. Identification can be made more positive by splitting the midrib of an infected leaf, whereupon a yellowish pus-like substance will ooze out. When the disease is in a very early stage the pus will not ooze out,but spots of it can be seen in the flesh of the split leaf stalk or part of the pseudostem. Subsequently these symptoms can be seen in all parts of the plant including the corm. The Welaita name for bacterial wilt disease is "wol-uwa".

Usually farmers uproot plants affected by bacterial wilt to prevent its transmission to other plants in the plantation. They also avoid the use of the same knives on infected as on non-infected plants and plantations. Other "traditional" practices are also used, eg burning the flesh or bones of certain wild animals,in order to "fumigate" the plantation, heaping very large

quantities of fresh manure around the stem of infected plants in order to "cure" them, planting certain strong-smelling trees and shrubs within the plantation, etc. The extent of or reasons for the efficacy of such practices is not known.

The principal author noticed that almost all the plantations infected by bacterial wilt were neglected and weedy. This neglect may have arisen because of the disease, ie farmers no longer found it worthwhile to maintain a plantation once symptoms of the disease were found in it, because all plants are likely to become infected whatever the care then given to it. On the other hand it is also possible that the neglect leads to conditions favouring the infection of plants with the disease, ie the neglect is a cause of the disease.

Another disease of enset identified by farmers in the Buge area of Damot Gale awraja first attacks the internal soft part of the central shoot. The shoot decays right down to the corm and its color turns darkish. Farmers simply describe this as "the enset disease" and it is not clear whether this is bacterial wilt.

The symptom of yet another disease described by farmers under the name "woka", is that the leafsheaths of the pseudostem dry up and darkens in color. Farmers believe some varieties (clones) are resistant to woka.

Another problem widely mentioned by farmers is called "Gote" (Wel. It is pronounced "Gotay"). In fact it is not clear whether this is a disease or a pest (eg a nematode). The symptoms are that the roots and corm are destroyed and finally the whole plant falls down.

Yet another disease mentioned by farmers is called "tsointe". According to the farmers it affects mainly the corm and can be only be diagnosed at night when the affected part glows (although this seems improbable).

Pests

A variety of pests (as yet not identified by the FARM team but including American Bollworm) cause considerable damage to the leaves, the central shoot and the corm of the enset plant. More important pests than insects are various kinds of wildlife. Altitude, landscape, and human population density determine whick kind of wildlife poses the main problem and how serious this is. Moles, porcupines, pigs (mainly warthog), baboons, vervet monkeys and crows are the main wildlife pests.

Shortages of land and labour

Only in Sura awraja was labour shortage (due to the absence of the men working as weavers in the towns of Ethiopia) reported as a serious constraint on enset production. In this case it was preparing and manuring the land that was difficult to carry out, and in some years a considerable proportion of the land is left uncultivated as a consequence of the absence of a large part of

the male labour force. In other years when the demand for weavers is depressed the males return home and start to cultivate again. In other awrajas, especially Damota, Damot Weide and Boloso Sore, shortage of land was cited as a constraint.

Climate

Enset appears to grow best in rainfall regimes with an annual total of between 1100 and 1500 mm fairly well distributed throughout the year. However it is tolerant of short drought periods.

"Frost-bitten" enset plants were seen in Kemba awraja at an altitude of about 2500 metres along the river. The top portions of the leaf seemed to be the most affected; but according to local farmers frost-bitten plants soon recover and frost is not a serious problem.

Villagisation

Villagisation, where carried out, appears to have had a negative effect on enset production. In a number of cases villagisation required removal of people from higher to lower areas. Their maturing enset plantations were left behind but no longer received the same intensive care in the form of manuring, weeding, and protection from wild animals. Manuring, in particular, became very difficult because of the problem of transporting the manure from the new villages, where the animals are corralled, to the old plantations. Sometimes the new lower areas of settlement in villages were climatically unsuited to enset production.

The age structure of enset plantations

One view expressed by farmers, particularly at Buge in Damot Gale awraja, was that a combination of drought and bacterial wilt disease have led to an unbalanced age structure in the enset plantations due to the fact that the low yield per mature plant caused by these problems led to the necessity of harvesting many immature plants in order to meet family food needs in the drought/disease years. This in turn reduced the number of plants that would become mature in later years. To give a simple example. If a family needs 18 plants per year for food in "normal" years, and mortality of plants in all years prior to maturity at age 7 years is 25% (this is a completely fictitious figure), then in normal years a family of stable size needs at minimum a total live enset plantation with the following age structure:-

Age in years	No. of live plants needed
>6 (year of harvesting)	18
5-6	24
4-5	32
3-4	43
2-3	57
1-2	76
0-1	101
TOTAL	351

Suppose that now a year comes when the low yield per enset plant (or the failure of other crops) means that 18 mature plants do not provide the necessary food. Then a family with only the "minimum"-sized plantation will need to harvest some 5-6 year-old plants to make up the deficit. This will in turn create a shortage of 6-year old plants in the following year; and so on.

A sample of nineteen farmers in Damota awraja was taken in the FARM Africa 1991 survey, and the age structure of their enset plantations recorded. The sample was biased away from selecting from the smallest plantations. Table 10 shows the result.

Table 10 provides a certain amount of support for the thesis of an unbalanced age structure caused by premature cutting. The "poor" group do not have enough plants in the last two age groups (4-5 and 5+) taken together to provide the 18 mature plants specified above as necessary to provide 50% of a family's annual food. Moreover there is a markedly lower proportion of the total stock of plants held in the last three age categories by both of the lower wealth groups than by the two wealthier groups. It does indeed look as though hunger is forcing them to nibble away at their capital stock of enset

Table 10 . The age structure of enset plantations

Wealth of farmers	Average no. of enset plants of age (in years) shown (Figures in brackets are percentages of total number)						
	0-1	1-2	2-3	3-4	4-5	5 +	Total
Very rich	808	420	415	348	120	15	2111
	(38)	(20)	(20)	(16)	(5)	(1)	(100)
Rich	354	353	127	63	74	33	1003
	(35)	(35)	(13)	(6)	(8)	(3)	(100)
Medium	291	276	93	54	39	0	752
	(39)	(37)	(12)	(7)	(5)	(0)	(100)
Poor	204	59	28	23	10	3	328
	(62)	(18)	(9)	(7)	(3)	(1)	(100)

Source: FARM Africa 1991 survey

Wealth in Table 10 is assessessed solely in terms of number of enset trees. The sample size and wealth limits were as follows:

Wealth group	No.of plants in enset holding	No. in sample
Very rich	> 1200	4
Rich	900 - 1199	5
Medium	600 - 899	5
Poor	< 600	5

Summary of constraints

Table 11 summarises the discussions held with farmers, during the FARM 1991 survey, on the subject of constraints in the existing production system. Two points emerge from a careful reading of this table. Firstly, although the same problems tend to get mentioned more or less throughout the region, there are substantial differences between awrajas in farmers' ratings of the severity of the individual problems. For example, baboons which are very or extremely destructive in Gardula and Sura, only just get mentioned in Damota and Damot Gale. Secondly there is a slight regional pattern. Ratings of destructivity in respect of a particular constraint given by farmers in an awraja in the Welaita group (Damota, Damot Gale, Damot Weyde) tend to be closer to ratings given in other awrajas in the same group than to the ratings, in respect of the same constraint, given in the southern group of awrajas (Gardula, Kemba, Sura).

Table 11. Constraints in the existing production systems

Constraints	Awraja																	
	DAMOTA			DAMOT G			DAMOT W			GARDULA			KEMBA			SURA		
	D	WD	K	D	WD	K	D	WD	K	D	WD	K	D	WD	K	D	WD	K
DISEASE																		
-Bacterial wilt	1	2	1		1	1		1	1		4	1	1	1	1	3	2	1
-Oka											4					3		
-Tsointe										?	?	?	?	?	?	?	?	
-Gote	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?	?
INSECTS																		
-Bollworm																3		
-Unidentified	2	3	2		1	2		2	1	3	3	4	3	4	2	3	2	2
WILD LIFE																		
-Porcupines	2	2	1		2	1		2	2	2	2	2	1	2	2	2	2	2
-Moles	2	2	1		2	1		2	1	3	2	1	3	3	1	4	3	1
-Baboons	1	1	1		1	1		2	2	0	4	4	0	3	1	0	4	5
-Pigs	1	1	2		2	0		2	2	0	3	5	0	2	3	0	4	5
-Crows	1	1	1		1	1		1	1	1	2	1	1	2	1	1	1	1
SOCIO ECONOMIC																		
-Shortage of land	3	5	1		4	1		4	1	3	3	1	2	1	0	3	0	1
-Shortage of labour										3	2	?	0			2	5	?
-Villagization	3	3	?		2	?				5	5	?		0	?	0	0	?
CLIMATIC CONDIT.																		
-Drought	1	3	4		3	4		3	4	1	2	4	1	1	4	1	3	4
-Frost	1	0	0		0	0		0	0	1	0	0	2	0	0	1	0	0
-Soil fertility	2	2	2		2	2		2	2	2	1	1	1	1	0	2	2	1

Source: FARM Africa 1991 survey

The severity of constraints (0-5 rating system)
- 0 - Mentioned by farmers but not really destructive
- 1 - Slightly destructive
- 2 - Moderately destructive
- 3 - Destructive
- 4 - Very destructive
- 5 - Extremely destructive
- ? - Mentioned as a constraint but severity not evaluated

D = Dega; WD = Weina Dega; K = Kolla

These severity ratings are fairly subjective and influenced by recent events, eg in the case of enset wilt the higher severity rating in Gardula than in Damot Weyde almost certainly reflects the fact that at the time of the 1991 survey Gardula was suffering from a "wave" of enset wilt whereas Damot Weyde was in a "trough" following a wave some years ago. There is no reason to believe that, at the crest of a wave, enset wilt is any less destructive in Damot Weyde than in Gardula.

CHAPTER 6: EXISTING CONSUMPTION AND MARKETING PATTERNS

The consumption and marketing patterns for enset vary in detail between years and between areas. However, in general, enset products are consumed and sold throughout the year although both domestic (ie the farmer's own household's) and market demand is highest between the months of March and July inclusive. This is because during these months the previous (Gregorian) calendar year's harvest of other crops runs out and farmers become heavily dependent on their enset to carry them through until the other crops planted in March of the current calendar year become ready for harvest. Another regular peak of demand is at the Meskel festival in late September. In dry years, when other crops do not yield well, both domestic and market demand for enset rises to the benefit of those with enough mature live enset or stored kocho to sell.

Tables 12 - 14 show, for the various enset products in different agro-ecological zones of the awrajas concerned, the proportion of the product that is sold in the market (the balance is consumed at home) and the price in the second quarter of 1991 at which it was being sold. In the cases of Tables 12, 14, and 15 the "price" quoted is actually "the market value" per plant of variable and unknown weight rather than a price per fixed and known unit of weight.

Table 12. The proportion of kocho produced that is sold in the market, and its price in various parts of North Omo Region in 1991

Awraja	Proportion (%) of kocho production that is sold			1991 local market price (ETB per plant)*		
	Dega	W.-Dega	Kolla*	Dega	W.-Dega	Kolla
Boloso Sorie	-	28	0	-	10	-
Damota	25	30	0	10	12	-
Damot Gale	-	15	0	-	10	-
Damot Weide	-	30	0	-	10	-
Gardula	22	35	0	40	45	-
Kemba	20	30	0	35	40	-
Sura	30	15	0	35	38	-

Source: FARM Africa 1991 survey data
* 0 includes negligible
- = Not applicable because there is no such agro-ecological zone in that awraja or (in case of price) none is sold
* There is a suspicious resemblance between these prices for "kocho only" per plant and those for "the complete plant" (including other products) given in Table 15 below, which suggests that the questions and answers may not have been mutually understood.

Table 13. The proportion of workay (Wel. godeta) * produced that is sold in the market, and its price in various parts of North Omo region in 1991

Awraja	Proportion (%) of workay production that is sold			1991 local market price (ETB per kg.)		
	Dega	W.-Dega	Kolla*	Dega	W.-Dega	Kolla
Boloso Sorie	-	20	0	1.80	2.00	2.50
Damota	50	20	0	2.00	2.20	3.00
Damot Gale	-	60	0	-	3.00	3.20
Damot Weide	-	30	0	-	2.20	2.40
Gardula	32	35	0	7.00	7.00	8.00
Kemba	35	40	0	2.50	3.00	4.00
Sura	30	25	0	2.00	2.20	2.50

Source: FARM Africa 1991 survey
* 0 includes negligible
- = Not applicable because there is no such agro-ecological zone in that awraja or (in case of price) none is sold.
* Workay (Wel. godeta) is pounded up corm and/or chopped up stalk of inflorescence.

Table 14. The proportion of enset fibre produced that is sold in the market, and its price in various parts of North Omo Region in 1991

Awraja	Proportion (%) of fibre production that is sold			1991 local market price (ETB per plant)		
	Dega	W.-Dega	Kolla*	Dega	W.-Dega	Kolla
Boloso Sorie	-	70	0	-	0.40	0.40
Damota	80	70	0	0.60	0.50	0.70
Damot Gale	-	65	0	-	0.50	0.70
Damot Weide	-	70	0	-	0.50	0.65
Gardula	85	80	0	0.40	0.50	0.55
Kemba	83	72	0	0.50	0.40	0.70
Sura	80	80	0	0.40	0.35	0.40

Source: FARM Africa 1991 survey
* 0 includes negligible
- = Not applicable because there is no such agro-ecological zone in that awraja or (in case of price) none is sold

Processed products of enset are not the only things to be sold. Sometimes the complete live plant, before harvesting and processing, is also sold. Table 15 below shows the prices being paid in early 1991.

Table 15. Market prices paid for complete unprocessed mature enset plants in North Omo region in 1991

Awraja	Price (ETB) per complete plant
Boloso Sorie	10
Damota	12
Damot Gale	10
Damot Weide	11
Gardula	45
Kemba	40
Sura	38

Source: FARM Africa 1991 survey

As can be seen there is a very marked difference in price per plant between the northern and southern awrajas of the region. Two reasons for this can be advanced. Firstly that the enset in the southern awrajas is grown at a higher altitude where the plants reach maturity (flowering) not only at a much greater age but also at a much larger size. Secondly, because of supply and demand conditions. This second explanation is also supported by the price differentials for the other products shown in Tables 12 and 13, although it seems odd in relation to the normal relative ease of transport between the northern and southern parts of the region. However at the time of the survey, motor transport was badly disrupted by an acute shortage of fuel which drove black market fuel prices above 10 ETB per litre.

We can supplement the price data given in Tables 12-15 by data on prices in Soddo market on three successive saturdays in August 1991. This market is really a wholesale rather than a retail market for enset products. Table 16 presents these data, but it should be noted that although the prices are quoted on a per kg. basis the normal unit sold in Soddo market is a 5 kg block in the case of both bulla and kocho.

Table 16. Prices of kocho and bulla in Soddo market on three successive saturdays in August 1991

	Price in ETB per kg		
Product	August 3rd	August 10th	August 17th
Kocho	0.70	0.80	0.80
Bulla	1.80	2.00	2.00

Source: FARM Africa 1991 survey

The relative importance of enset in the diet of different areas differs, and if data were available, can be expressed in different ways. One such way is the proportion of households who claim to consume it. Table 17 shows the proportion of households

(sample size was about 1870 households) who claimed in 1976 to consume different crops in the Kokate area, just east of Soddo town.

Table 17. Proportion (%) of households claiming, in 1976, to eat various crops in the Kokate area of Damota awraja.
(n= 1870)

Crop	% of households claiming to consume this crop
Enset	96.7
Maize	75.9
Barley	43.6
Sorghum	27.2
Beans	35.0
Chickpeas	35.8
Horse beans	28.4
Sweet potatoes	29.5
Wheat	12.6
Irish potatoes	40.4
Teff	21.2
Taro root	23.5
Welaita potatoes	0.3
Yam	6.9

Source: WADU agricultural survey of Kokate (October 1976)

During a training course on Rapid Rural Appraisal methods during July 1991 course participants interviewed a number of people in the weina dega area of Damot Weide awraja about their household consumption patterns. The answers given by three of these respondents are summarised in Figure 4 a-c below to show the percentage of total annual household food consumption coming from various crops. As can be seen, the proportion that enset forms of total household consumption ranges from a high of about 40% to a low of 5%. Most respondents mentioned that enset had been more important in the past but had declined either due to villagisation or to bacterial wilt.

It is not yet clear how far this picture of a decline in the importance of enset from a dominant to a more modest place in household diet is generalisable to other areas.

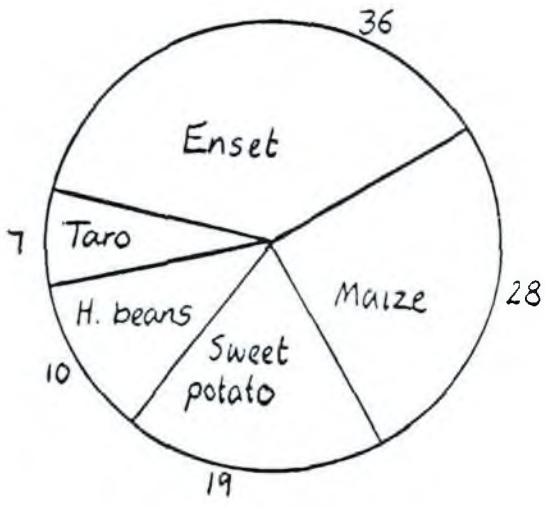


Figure 4a: Diet proportions (Case 1: younger man)

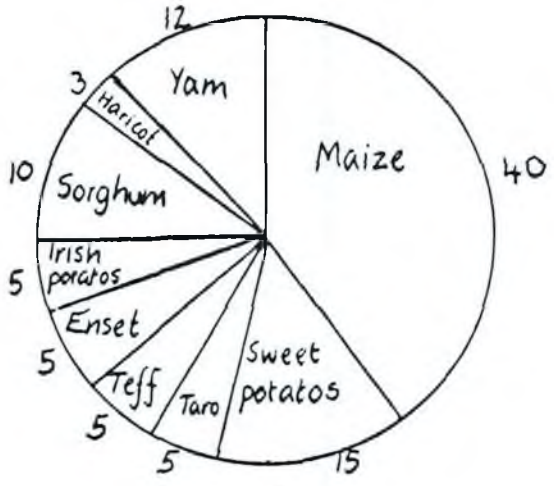


Figure 4b: Diet proportions (Case 2: middle aged man)

Figure 4c: Diet proportions (Case 3: middle aged woman)

Figure 4: The place of enset in the human diet in the weina dega zone of Damot Weide awraja.

CHAPTER 7: PAST AND PRESENT RESEARCH ACTIVITIES

This chapter reviews some of the more important past and present research activities in enset production and processing. Much of the research on enset in the past was of a survey nature, designed to identify and estimate the basic characteristics of enset production. Much of the results of such research has already been incorporated in previous chapters and will not be reviewed again here.

There have been three main locations of research. The first was the Debre Zeit agricultural research centre of the Alemaya College (now University) of Agriculture. This worked actively on enset in the early 1970s. In the second half of the 1970s the main location of enset work was at WADU (the Wollamo [Welaita] Agricultural Development Unit) station at Soddo under the leadership of Teketel Makisso. That station closed down its enset work in 1982 due to the ending of the WADU project. Finally since 1989 work has been going on at the research sub-centre of the Institute of Agricultural Research (IAR) at Areka in Boloso Sorie awraja. It has not yet, however, been going on long enough for results and publications from this work to be available.

Rather little research has been oriented to testing how the productivity of enset production can be improved and there have been correspondingly few experiments with this objective. The experiments that there have been can be classified into four groups as follows:-

- Varieties (clones)
- Spacing
- Number of transplantings
- Processing devices

We briefly review the principal results of each group, to the extent posible giving a standardised description of each trial.

Variety (clone) trials

Two straight variety trials have been carried out, one at Debre Zeit and one at WADU. The results are summarised in tables 18 and 19.

These variety trials only tested 7 out of a potentially very large number of varieties (clones). Of these seven only two (Adow and Tuzuma --both included in the Debre Zeit but not the WADU/Soddo trial) are included in the list of local varieties given in Table 8 above. As mentioned earlier in this report, farmers tend each to grow a number of different varieties, and each has its own uses and advantages (eg speed of maturity, drought resistance, etc.). Variety trials in future should consider including some further criteria of choice in addition to the ones used in previous trials of kocho/fibre yield at a particular age at harvest/period from last transplant.

Table 18. Yields of food and fibre from some enset clones in Debre Zeit

Clone (Variety)	Av. yield of kocho per plant (kgs)	Av. yield of fibre per plant (kgs)
Fereza	15.8	0.24
Adow	10.7	0.21
Tuzuma	18.4	0.31
Medisho	?	0.38

Source: Adapted from Debre Zeit Agricultural Research Centre, 1975-1976 and quoted in Demeke 1985.

Standardised description of trial reported in Table 18
No. of plants per treatment (variety): Not reported.
Age at harvest (months from planting suckers away from mother corm): Not reported.
Period (months) from last transplant to harvest: Not reported.
Number of times transplanted: Not reported.
Spacing: 1600 per ha..
Product in which yield is measured*: Post fermentation.
Statistical significance of results: Not reported.

* ie pre-fermentation, post-fermentation, or refined.

Table 19. Yield of food from some enset clones in Soddo

Clone (Variety)	Yield of kocho per plant (kgs)	Total number of plants harvested
Sepere	26.1	14
Siskala	28.1	32
Ginbo	28.0	32
MEAN YIELD	27.3	78

Source: WADU crop and pasture section agronomic report 1977/78 and 1978/89. WADU Publication 62

Standardised description of trial reported in Table 19
No. of plants per treatment (variety): See body of table.
Age at harvest (months from planting suckers away from mother corm): Not reported.
Period (months) from last transplant to harvest: 22.
Number of times transplanted: Not reported.

Spacing: 2.5 X 2.5 m. (6.25 m^2 per plant).
Product in which yield is measured*: Refined kocho including all pounded up corm.
Statistical significance of results: No statistically significant difference.

* ie pre-fermentation, post-fermentation, or refined.

Spacing trials

The results of a spacing trial carried out at Soddo in 1976-78 are shown in Table 20. They reveal a slight, but not very strong (r_2 = 0.57) simple correlation between yield and space available (m^2 per plant). For some reason a spacing of 1.5 metres between plants gives a much higher yield per hectare irrespective of the spacing betwen rows.

Table 20. The spacing and yield of food per plant

Spacing (linear m.)	Spacing m^2 per plant	Spacing Plants/ha	Yield of kocho kgs per plant	Yield of kocho tons per ha
2.0 X 1.5	3.00	3333	21	70
2.0 X 2.0	4.00	2500	18	45
2.0 X 2.5	5.00	2000	23	46
2.5 X 1.5	3.75	2666	22	59
2.5 X 2.0	5.00	2000	21	42
2.5 X 2.5	6.25	1600	21	34
3.0 X 1.5	4.50	2222	31	69
3.0 X 2.0	6.00	1667	20	33
3.0 X 2.5	7.50	1333	42	56
Mean	5.00	2000	24	48

Source: WADU crop and pasture section agronomic report 1977/78 and 1978/89. WADU Publication 62.

Standardised description of trial reported in Table 20

No. of plants per treatment: 18.
Age at harvest (months from planting suckers away from mother corm): Not reported.
Period (months) from last transplant to harvest: 30.
Number of times transplanted: Not reported.
Spacing:See body of table
Product in which yield is measured*: Refined kocho including all pounded up corm.
Statistical significance of results: Not reported.

* ie pre-fermentation, post-fermentation, or refined.

Number of transplantings

Peasant farmers in North Omo region may transplant their enset up to a further three times after the initial planting of the sucker on its separation from the mother corm. At each transplanting the

plant is severely cut back, and at different transplantings different spacings beteen plants may apply. Two trials were down (one by WADU, one at Debre Zeit) to test the effect that the number of transplantings has on final mature yield. The results are shown in Tables 21 and 22.

Table 21. A comparison of the effects on growth and yield of transplanting and not transplanting at Soddo.

Measurement of growth or yield	Not* transplanted	Transplanted once *
Circumference (cm) 20 cms above ground	170	191
Circumf. (cm) 100 cms above ground	123	128
Height of pseudostem (cm)	218	236
Yields of Kocho (kgs per plant)	20.7	25.9

Source. WADU crop and pasture section agronomic report 1979/80
* After the initial planting of the sucker on its separation from the mother corm.

Standardised description of trial reported in Table 21
No. of plants per treatment: 48.
Age at harvest (months from planting suckers away from mother corm): 38.
Period (months) from last transplant to harvest: 38.
Number of times transplanted: See body of table.
Spacing: 3.00 X 1.5 m. (4.5 m^2 per plant)
Product in which yield is measured*: Refined kocho including all pounded up corm.
Statistical significance of results: Observational trial, not intended for statistical analysis.

* ie pre-fermentation, post-fermentation, or refined.

Table 22. The performance of enset plants under different transplanting treatments

Measurement of performance	Number of transplantings* None	One	Two	Three
Pseudostem height. (m.)	2.9	2.2	1.5	0.9
Circumference at base (m.)	1.9	1.9	1.7	1.3
Height of top of leaf (m.)	4.0	3.7	2.9	2.1
Number of leaves	10	11	10	12

Source: Annual report of Debre Zeit Experimental Station 1984/85 quoted in Demeke 1985
* After the initial planting of the sucker on its separation from the mother corm.

Standardised description of trial reported in Table 22

No. of plants per treatment: Not reported.
Age at harvest (months from planting suckers away from mother corm): 18.
Period (months) from last transplant to harvest: 18.
Number of times transplanted: See body of table.
Spacing: Not reported.
Product in which yield is measured*: Results not expressed in yield terms.
Statistical significance of results: Observational trial, not intended for statistical analysis.

* ie pre-fermentation, post-fermentation, or refined.

Processing devices

It normally takes one person (usually a woman) about one day each to process by hand a mature pseudostem and associated inflorescent stalk and corm. However some varieties (eg Tuzuma) are much more difficult to scrape and take longer. In an effort to reduce the time involved the appropriate technology department of the IAR at Nazareth developed various devices. These were:-

- Corm slicer and mincer
- Corm slicer and grater

The results of this work can be read in the 1977 report of the enset processing devices project (IAR 1977).

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FARMERS RESEARCH PROJECT

Introduction

This publication has been financed under the work programe of the Farmers Participatory Research Project. This project, which is designed and coordinated by FARM Africa, a British-registered charitable organisation, is focused on the North Omo Region in south-west Ethiopia. The project started in early 1991 and the first phase is expected to last four years.

Objectives of the project

The overall aim of the project is to increase the capacity of NGOs and other organisations to contribute to farmer-oriented research in which farmers themselves participate. Under this overall aim, specific objectives are:-

* To build a channel of communications between NGOs and research institutions;

* To make resource-poor farmers more aware of their need for research;

* To help farmers realise their own ability to do research;

* To assist farmers to do and to disseminate their own research;

* To test techniques for encouraging community- and farmer-managed research;

* To inform research scientists in Ethiopia of farmers' research priorities.

Further information

Further information about this publication and the farmers research project can be obtained from:

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