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Cultivation, Preparation and Consumption of Ensete (*Ensete ventricosum*) in Ethiopia

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Abstract: In Ethiopia almost 10 million people are dependent on ensete (*Ensete ventricosum* (Welw) Cheesman), also known as 'false banana'. In the Gurage area in Central Ethiopia, agronomic and nutritional aspects of ensete were studied in 60 households in six villages. Ensete is propagated vegetatively and has a 6-year growing cycle during which it is transplanted three or four times. Men harvest the plants; women scrape the pseudo stem in order to separate the starchy pulp from the fibre, and pulverise the corm. The pulp is fermented and stored for up to 5–7 years in earthen pits. The yield of ensete food (ko'cho) was found to be 34 kg per plant or 9·5 tons ha^{-1} per year. Compared with other foods grown in Ethiopia, the energy yield of ensete (6·1 MJ m^{-2} per year) was higher than that of all cereals, Irish potato, sweet potato and banana, but lower than that of cassava. The protein yield of ensete was higher (11·4 g m^{-2} per year) than all of the crops mentioned above, except for banana and Irish potato. To make ensete bread, fermented pulp is squeezed to make it drier, chopped to shorten the fibres and a 2 cm layer is baked for 15 min. Unfermented freshly harvested corm is also eaten after boiling. All foods have a low protein content (4–22 g kg^{-1}). Bu'lla, white desiccated juice collected from the pulp, is more energy rich (8·5 MJ kg^{-1}) than ko'cho (6·5 MJ kg^{-1}). A dietary survey, conducted in 39 households comprising 237 persons, showed that the average daily intake of 0·55 kg ensete provided 68% of total energy intake, 20% of protein, 28% of iron but no vitamin A. Energy intake from all food consumed was very low, being only 60% of requirements, while protein intake at 107% was ample. Since ensete can be stored for years, is readily available throughout the year and can withstand dry periods, its cultivation can significantly improve household food security in highland areas prone to drought and famine.

Key words: *Ensete ventricosum* (Welw, Cheesman), Ethiopia, cultivation, harvesting, yield, preparation, food value, consumption, nutritional requirements.

INTRODUCTION

Ensete ventricosum (Welw, Cheesman 1947), usually referred to as 'ensete', provides the staple food for 8 million people in the most densely populated areas of Ethiopia. These areas, located in the South and South-West, are inhabited by the Gurage, Sidama and related tribes. It is the co-staple food for a further 2 million people in the South-West and West of the country. Altogether they comprise about one-fifth of the population (Westphal 1975; OPHCC 1984). It grows best at an altitude of 1600–3000 m and can withstand dry periods (Huffnagel 1961; Westphal 1975).

Ensete is grown in a semi-permanent cultivation system marked by a complex cycle of transplanting reported to last from 5 to 10 years (Shack 1966). Because of its resemblance with the banana plant it is also referred to as 'false banana'. However, it does not bear edible fruit. Its corm and pseudo stem are used for

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the production of starchy foods such as 'ko'cho' obtained from pulp of the pseudo stem and corm, and 'bu'lla' which is a desiccated juice collected from the pulp (Besrat *et al* 1979). These are fermented and stored in a pit for a period lasting from a few days up to 5 years (Gashe 1987). From the good physical appearance of the Gurage and Sidamo people, Smeds (1955) concluded that ensete food is deservedly highly appreciated for its health stimulating qualities. The plant also provides fibre which is used for rope, sieves and cleaning material (Huffnagel 1961). Ritually prepared ensete has an important role in birth, circumcision, marriage, and death ceremonies (Shack 1963).

As already noticed by Smeds (1955) and Stanley (1966), ensete had not been thoroughly investigated and up until the time that the present study was carried out this was still the case. Most of the previous information was collected several decades ago in Sidamo Region. The Gurage, inhabiting an area about 200 km north of Sidamo, are heavily dependent on ensete, and are the best known ensete growers (Stanley 1966). The present paper reports the results of a study on agronomic and nutritional aspects of ensete conducted recently in the Gurage area in southern Shoa.

METHODS

Study area and design

The present study was conducted in six villages within a radius of 6 km around Attat Hospital, located in Chebona-Gurage Province 175 km south-west of Addis Ababa. The area, at an altitude of 1900 m, is densely populated by the Gurage (135 persons km^{-2}, CSA 1986). The fieldwork was carried out by the first two authors with assistance from two Gurage interpreters. Sixty households cooperated in the study; the dietary survey was carried out in an additional 39 households.

Cultivation, harvesting and preparation

All activities involved in the cultivation, harvesting and preparation of ensete were observed repeatedly in several households, until detailed and consistent descriptions were obtained. Some processes could not be observed and were therefore described by the people themselves. Meetings of women's groups in two villages were attended in order to obtain additional information. Questions formulated in advance were addressed to the group as a whole and were answered by several women. In this paper, descriptions written in italics of plants, processes, tools and other terms are followed by their Guragegna names in parentheses.

Yield

The area used for the cultivation of ensete was calculated from width and length, as measured by pacing, of the usually rectangular plots. Pace length of the two investigators was calibrated. The head of the household was asked for the average (used in the calculation), minimum and maximum number of plants harvested yearly from that plot.

The yield per plant of fermenting pulp was determined by weighing pulp from a number of plants with a Seca bathroom scale at the time that the pulp was put into an earthen pit for storage. The yield of light- and dark-coloured pulp (wu'ssa) was measured separately. The yield of desiccated juice (bu'lla) was measured on four occasions. The products are fermented further in the earthen pit, pressed by stones, squeezed, cut, mixed with water and baked prior to consumption. In order to estimate the proportion of fluid loss and added in the course of this processing, several measurements were carried out. First, the fluid lost during storage and through squeezing before baking was estimated. If the pulp is prepared after a relatively short period of storage, the pulp is squeezed to obtain a rather dry product which was assumed to be as dry as older pulp not needing to be squeezed. To estimate this loss of fluid, women were asked to squeeze homogenised samples of 2-week-old ready-for-storage pulp. Finally, the overall weight change as a result of adding water during further preparation and from evaporation during baking was determined. The yield of the final food was calculated by combining the data on the number of plants harvested per unit area, the amount of harvested pulp per plant, and the weight changes during further processing.

Food value

Food samples were stored at −20°C. Moisture content was determined by drying 16–18 h at 92°C, the boiling point of water in Addis Ababa which is at an elevation of 2400 m. Nitrogen was determined by the Kjeldahl method as described in the manual of the manufacturer of the equipment used (Tecator, Sweden). Protein content was calculated by multiplying nitrogen content by 6·25. Crude fibre, determined by the Weende method in a muffle furnace at 500–550°C, and ash were analyzed as described by Kirk and Sawyer (1991). Fat was determined by the Soxhlet procedure, in which dried samples were extracted with peroxide-free diethyl ether for 4 h. Then carbohydrate was calculated by difference from the values for protein, fat, crude fibre and ash. Energy content was calculated by applying the Atwater factors: 17 kJ g^{-1} for protein and carbohydrate and 38 kJ g^{-1} for fat.

Consumption

Forty-seven households were selected for a dietary survey. Their dietary intake was estimated using a 3-day weighed record in which food quantities were weighed immediately prior to eating or by weighing duplicate portions, using a Salter kitchen scale. The survey was conducted in October 1989 by five local people, trained by an experienced dietician, and repeated 2 months later. Duplicate information could be collected in 39 households, comprising 237 persons (44% females) with a median age of 12 years. The MicroNAP program (version 4.21, Sevenhuysen and Schuppel 1989) was used to convert data on food intake to energy and nutrients. Recommended daily intakes for each individual based on his or her age and sex were derived from WHO and FAO publications (see Table 5 below). Adults were regarded as moderately active while average body weights of 50 kg for women and 55 kg for men were assumed. Since the diet of the Gurage is very limited in animal products, iron requirement was based on that for a low bio-availability diet. For energy and all nutrients, adequacy of intake was calculated by dividing total intake of the 39 households by the total requirement of the 237 persons they comprised. Finally, the contribution of ensete to total intake of energy and nutrients was estimated by dividing intake from ensete by total intake.

RESULTS

Cultivation

Figure 1 shows a mature ensete plant with *inflorescence* (shi'ra). In general, ensete is harvested before it starts flowering so the inflorescence is not often seen. All plants are *transplanted* (ku'bar) 3 or 4 times (Fig 2). This is done in the period January to March, when the space required for transplanting has become available after harvesting mature plants. Thus, the oldest plants are transplanted first. All the work involved in this is done by men and boys. Before the ensete is transplanted, the small adventitious roots, leaves, and outer shrunk layers of the pseudostem are removed with a large knife referred to as 'tebe'cha' (Fig. 3). It has an iron cutting part and a handle made out of any hard wood available. The cutting facilitates transport and is said to stimulate growth. Then the plants are pushed over or pulled out and planted in new holes, dug with a *two-pointed stick* (mare'sha), a *flat-edged stick*) (ta'rbe) and/or a spade. Two adults are needed to transplant the older, heavier plants.

For the vegetative propagation a hee'ba (Fig 2) is cut 15–25 cm above the ground. With an *old broken sibi'sa with a sharp cutting edge* (woge'nya; see Fig 3), the upper central part of the corm which remains is removed and buried under 10–20 cm soil mixed with cows' manure. The 50–150 sprouts which develop after a few weeks are transplanted 1 year later in groups of three, 1 m apart. After a further year, they are transplanted individually 1 m apart and after another 2 years, individually 1·5–2 meters apart. Intercropping of oranges (*Citrus sinensis*), coffee (*Coffea arabica*) and cha't (*Khat edulis*) is generally practised, especially in between hee'ba. Manure is applied to all plants in all stages of growth at least once a year. The duration of a growth stage may be extended if plants have not grown sufficiently at the time of transplanting. For example, the last stage may be extended from the usual 2 years up to 5 years.

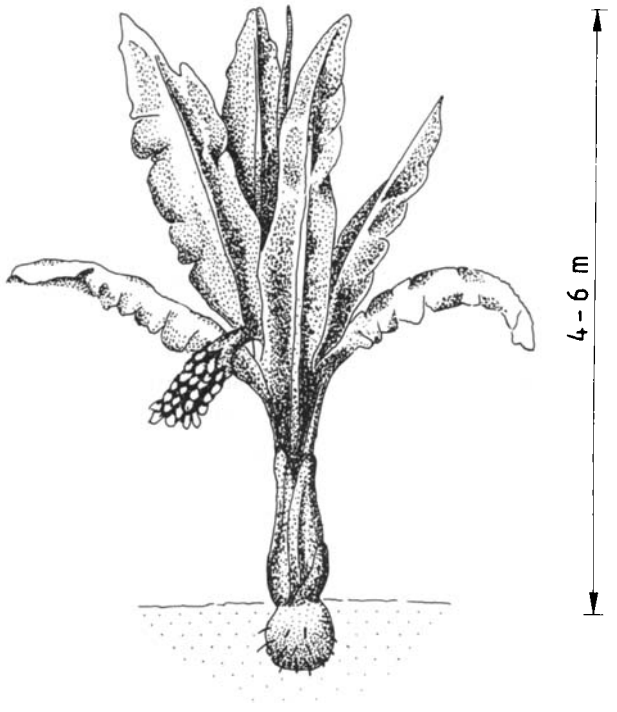

Fig 1. Full-grown ensete with inflorescence.

In the Gurage area, ensete is grown near the house on rectangular plots divided into sections, each with plants at the same stage of growth, referred to by the name corresponding to that stage. The more vulnerable young sprouts are planted close to the house whereas mature plants are found further away.

Harvesting and processing

Most of the ensete is harvested from November to January. All the work is carried out in the field itself, where usually 3 to 15 plants are harvested by a household on one day. Figure 3 shows tools that are very typical for cultivation and harvesting of ensete. Figure 4 presents an overview of the numerous products and complex processing of ensete, and might serve as guide while reading the following.

First the men select mature plants, prepare them and push them over (as described for transplanting under

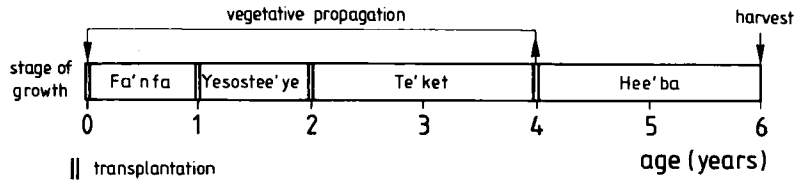

Fig 2. Stages of growth and transplantation of ensete.

Cultivation—see above), after which they are separated into various parts. All further processing is carried out strictly by women and girls. Smooth working sites are prepared with leaves of which the convex sides of the *ribs* (chimbee'na) are removed with a *curved knife* (woka'ra). The site where the pseudo-stem is processed is referred to as yekasse're and where the corm is processed as yo'qute.

The pseudo stem is processed as follows. The *sheaths of the pseudo stem* (nechee'ya or gu'ppa) are separated, their concave sides are peeled, cut into pieces one meter long and split lengthwise. A *plank of wood* (2·0 m × 0·3 m) (wa'ttar) is placed against an ensete plant at an angle of 45°. While sitting on a stone, a woman uses one foot to hold a piece of a stem sheath up against the plank. First the lower part is scraped with a sibi'sa, a sharp-edged tool made out of bamboo wood (Fig 3). *Pulp* (kissa'ra) is collected underneath the plank and the *fibre* (ka'ncha), which remains on the plank, is wound around her foot. Then, the remaining part of the sheath is scraped. The wettest portion of pulp, collected right under the plank, is referred also to as 'yewatta'yre'. Urchee'ye and guneree'ye are scraped in a similar way, but its less appreciated pulp is kept separate, as also is the *fibre that remains* (kapsa'ssa). It is not as fine and as white as ka'ncha. All fibre is dried in the sun. Ka'ncha is used for many purposes such as rope, mats and bags while kapsa'ssa is used for squeezing fermented pulp of ensete.

The *outer soiled part* (zanzee'ye) of the *corm* (wo'quta) is removed with a tebe'cha (Fig 3). The remainder is pulverised into bure'ma, using the zigzag sharp-edged end of a zyeeba'nzyeebye (made from any available hard wood, Fig 3). The *most central part* (dida'pho) is often retained intact and used as payment for the labour of women not belonging to the household.

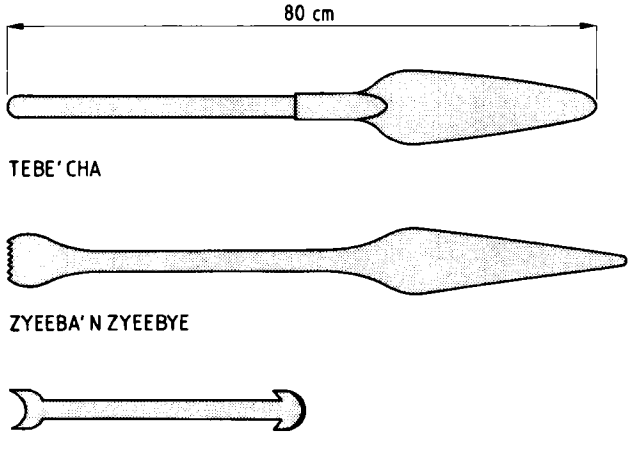

Fig 3. Tools typically used in the cultivation of ensete.

At the end of the day two mixtures are prepared: me'chee which is light-coloured and rather highly appreciated and tikuree'ye which is dark-coloured and not much appreciated. Usually guneree'ye is added to me'chee, but if a'tmet (a white fibreless food, see further) is produced, guneree'ye is added to tikuree'ye. *Both mixtures* (ti'kot) are put in layers 15–20 cm thick and covered with leaves, me'chee at the yekasse're site and tikuree'ye at yo'qute, and allowed to ferment for 10–15 days. The mixture of the fermented pulp from both sites is chopped up and transferred in a basket to an *earthen pit* (gua'ji) for storage. From then on it is referred to as 'wu'ssa'. A renovated existing pit or a newly dug pit is prepared by lining with ribs of leaves which are very resistant to decay. In the pit, pressure is applied to the wu'ssa: first by standing on it and then, after covering it with leaves, with heavy stones. As such it can be kept for a period of up to 7 years, and is readily available throughout the year.

In order to produce a'tmet, me'chee is placed in a basket, rinsed with water and squeezed. The basket is put on the *inner bark of sheaths of the pseudo stem* (a'ba), next to a *rectangular pit* (go'je) which is lined with *heated soft leaves* (yageko'ree) that make it watertight. A turbid fluid pours out through the basket and is collected in the pit. The pulp is rinsed repeatedly with the same fluid. Within several days the solid particles in the fluid settle out. After removal of the water the remaining solid is wrapped in leaves and put in the wu'ssa pit, usually underneath a layer of me'chee or tikuree'ye. By rinsing me'chee in order to produce a'tmet the nutritional value of me'chee decreases. Therefore, only a minor part of me'chee is used for the production of a'tmet, or no a'tmet at all is produced.

If the amount of ensete harvested does not supply sufficient food until the next annual harvest, extra plants are harvested as required, of which only the corm is consumed after being cooked without prior fermentation. The pseudo stem is fed to cattle.

Yield

On average 46 plants were harvested yearly per household, equivalent to a yield of 0·028 plants m^{-2} per year

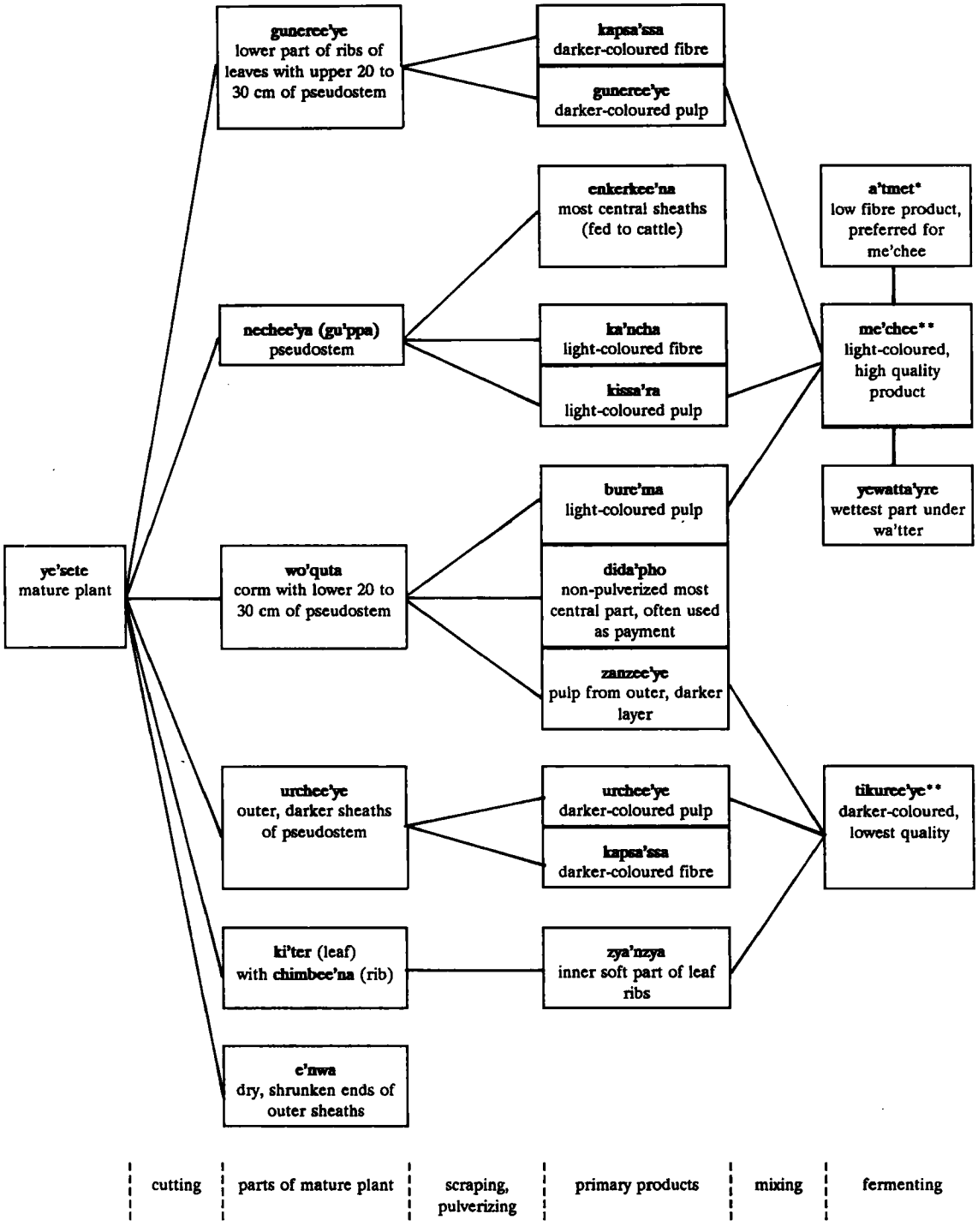

Fig 4. Harvesting of ensete. * For production of a'tmet, see text. ** Referred to as 'ti'kot' from harvesting until pulp is put in earthen pits. From then on it is referred to as 'wu'ssa'.

(Table 1). One plant yielded 28 kg of me'chee pulp, including that which may be subsequently purified to a'tmet, plus 14 kg of tikuree'ye pulp. Since only weight loss due to expression of fluid was observed (15, 21 and 22%), the estimated yield was 34 kg food per plant or 9·5 tons ha^{-1} per year. A'tmet was produced in only four out of 23 households at the time the study was conducted, yielding on average 2·1 kg per plant (range 0·3–3·8 kg).

Comparative data on the yield of foods prepared from other crops grown in Ethiopia are presented in Table 2. Protein yield (m^{-2} per year) from ensete was about 50% higher than protein yield from cereals, whereas yield in terms of weight and energy was even

TABLE 1
Yield of ensete in Gurage area, Ethiopia

	n	*Mean (SD)*	*Range*	
Yield of fresh fermenting pulp per plant, *a* (kg)	208	42 (9)	24	62
Proportional weight loss after squeezing pulp, *b*	3	0·19	0·15	0·22
Proportional weight change after baking pulp, *c*	14	0·00 (0·06)	−0·11	0·09
Yield of ensete food per plant, $d = a(1\text{-}b)(1\text{-}c)$ (kg)		34		
Number of plants harvested per household, *e* (per year)	45	46 (19)	12	110
Area used for ensete by household, *f* (m^2)	45	1615 (875)	335	3665
Number of plants harvested, $g = e/f$ (m^{-2} per year)	45	0·028		
Yield of ensete food, *d g* (kg m^{-2} per year)		0·95		

four times higher. Ensete also had a high yield in comparison with other tuber crops such as Irish potato and sweet potato. However, compared to cassava, ensete had a low energy and similar protein yield, whereas compared to banana, ensete had a higher energy and lower protein yield.

Food preparation

A number of foods are prepared from wu'ssa, wo'quta and a'tmet (Fig 5). In this section, the names of these foods are written in bold. In Amharic and other languages, **wu'ssa** and **a'tmet** are known as **ko'cho** and **bu'lla**, respectively. All foods are baked on a fire. The *fireplace* (go'dred), located centrally in the round house, comprises a circular raised concrete ring surrounded by earthenware pots supporting an iron *circular concave hotplate* (meta'd). Ensete foods are usually eaten with dried pepper (*Capsicum frutescens*), except for yicho'chee (Fig 5).

In order to prepare **asha'shat** or **da'puha,** the dough to be baked is processed as follows. An amount of fermented pulp sufficient for one to three meals is taken

TABLE 2
Yield of crops grown in Ethiopia, in terms of weight, energy and protein

Food[a]	*Yield*		
	Weight ($g\,m^{-2}$ *per year*)	*Energy (MJ* (*kcal*) m^{-2} *per year*)	*Protein* ($g\,m^{-2}$ *per year*)
Ensete (*Ensete ventricosum*)	950[b]	6·1 (1450)[b]	11·4[b]
	240[c]	2·0 (490)[d]	2·9[d]
Barley (*Hordeum vulgare*)	230[e,f]	1·6 (390)[f]	8·1[f]
Maize (*Zea mays*)	170[e,f]	1·3 (320)[f]	8·6[f]
Sorghum (*Sorgum vulgare*)	260[e,f]	1·5 (365)[f]	7·7[g]
Finger millet (*Eleusine coracana*)	170[e,f]	1·2 (290)[f]	6·5[f]
Teff (*Eragrostis teff*)	200[e,f]	1·4 (330)[f]	8·5[f]
Wheat (*Triticum vulgare*)	170[e,f]	1·3 (300)[f]	9·3[f]
Irish potato (*Solanum tuberosum*), grilled	500[c]	1·4 (335)[h]	11·5[h]
Sweet potato (*Ipomosea batatas*), boiled	420[c]	2·1 (510)[h]	3·4[h]
Cassava (*Manihot esculenta*)	880[i]	8·5 (2070)[j]	10·4[j]
Banana (*Musa acuminata*)	1110[i]	3·8 (910)[j]	16·6[j]

[a] Ensete was prepared as ko'cho, cereals as enje'ra, cassava was cooked, banana was raw.
[b] Present study.
[c] Ethiopia Statistical Abstracts 1967–1968, cited in Bezuneh (1971).
[d] ICNND (1959).
[e] CSA (1986).
[f] ENI (1980).
[g] Ågren and Gibson (1968).
[h] ENI (1981).
[i] Acland (1971).
[j] West *et al* (1988).

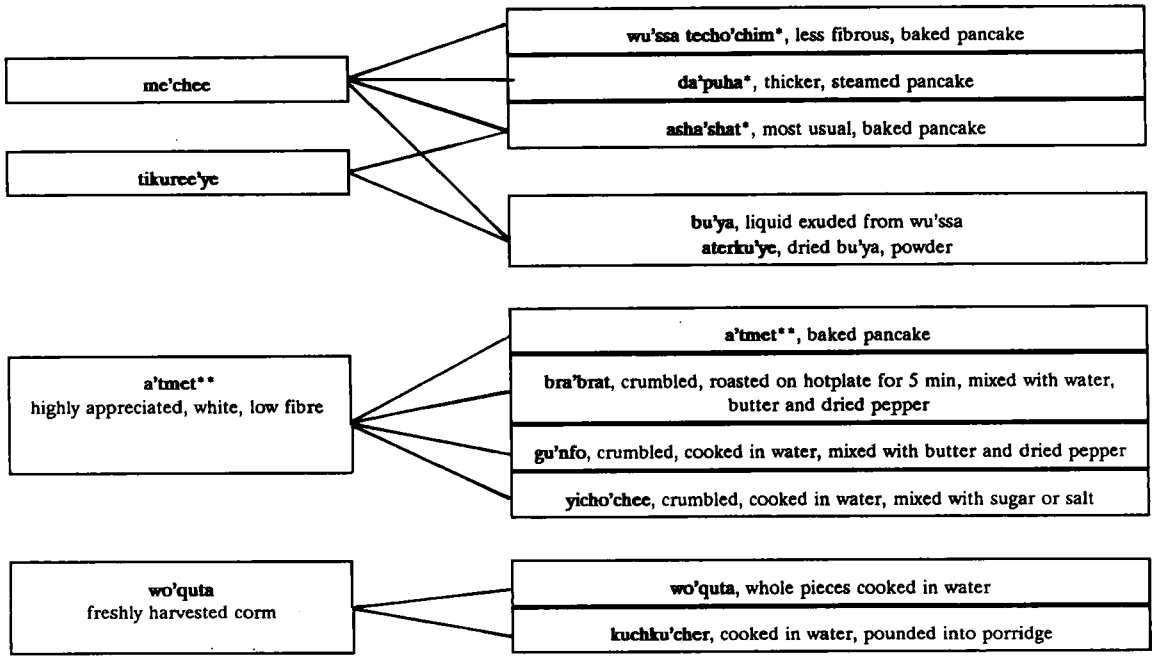

Fig 5. Preparation of foods from ensete. *In Amharic: ko'cho. ** In Amharic: bu'lla.

out of the pit. Pulp less than a few months of age has a rather high moisture content making it difficult to cut through the fibres. It is therefore wrapped in kapsa'ssa (Fig 4) and *squeezed* (yikoku'ree). The *liquid that exudes* (**bu'ya**) can be dried to **aterku'ye** (Fig 5). While being pressed on a *plank* (zebo're) with a *hooked wooden tool* (yichochee'que e'nche) which also protects the hand, the fibrous pulp is chopped. As the fibre slowly decays with time, less cutting is required the longer the pulp has been stored. The chopped pulp is *kneaded* (yishe'shee) on a *square mat made from ensete fibre* (yetephe'pe, 0·4 m square) until an elastic dough has been formed which sometimes requires the addition of water. Then it is baked or boiled for 10–20 min, except for when preparing da'puha which is steamed for 70–100 min.

To prepare **asha'shat** the dough is stretched out on the mat into a layer 1·5–2 cm thick, placed upside down on the hotplate and then baked on both sides. If a soft outer layer is preferred the dough might be baked while wrapped in ensete leaves, or moistened with water while it is on the hotplate.

In order to bake **da'puha,** usually on the occasion of religious feasts, the dough is stretched out in a some what thicker layer 3–5 cm thick and wrapped in two ensete leaves laid across one another. The wrapped dough is placed on the hotplate decked with narrow strips of leaf ribs and covered with further strips of leaf ribs which are then sprinkled with water. The dough cooks by steaming and is turned several times.

Wu'ssa techo'chim, a more refined food, is prepared from me'chee, which is kneaded while ample water is poured on to it. The liquid that pours out is filtered through thin pieces of wood covered with low-quality fibre. Larger fibrous particles remain on this filter. The filtrate is collected in a cotton bag which hangs in a clay pot, the bag serving as a second filter holding back smaller particles. The filtrate collected in the clay pot is added to bu'ya. The contents of the bag are kneaded and baked in a similar way as asha'shat. Since little fibre remains, the dough is always baked while wrapped in ensete leaves, preventing it from falling apart.

A'tmet is usually prepared similar to asha'shat, resulting in the typical, non-flexible thick pancake-like food, or 'ensete bread'. Also asha'shat, dapu'ha and wu'ssa techo'chim can be described as such. Since it contains practically no fibre it is not squeezed or cut, and is usually wrapped in leaves. Other foods prepared from **a'tmet** are **bra'brat, gu'nfo** and **yicho'chee** (Fig 5). Pieces of **wo'quta** are eaten after boiling for 20 min. Pounding of cooked pieces of the corm with a zyeeba'nzyeebye (Fig 3) results in a porridge **(kuchku'cher).**

Food value

All of the foods prepared from ensete in the Gurage area (Table 3) contained little protein (4–22 g kg^{-1}) and almost no fat (1 g kg^{-1}), so that 97% of the energy is present as carbohydrate. The nutritional value of the various foods did not differ substantially. The slightly higher moisture content of da'puha could be explained by the fact that it is steamed instead of baked. The fibre content of wu'ssa techo'chim was low because it is a more refined product. Compared with wu'ssa, a'tmet had a lower and wo'quta a higher moisture content.

TABLE 3
Composition and energy content of ensete foods expressed per kg[a]

	Asha'shat		*Da'puha*	*Wu'ssa techo'chim*	*A'tmet*	*Wo'quta*
	Me'chee	*Tikuree'ye*				
Number of samples	6	2	1	1	1	1
Moisture (g)	581	578	609	559	488	699
Energy (MJ)	6·50	6·38	6·07	7·07	8·46	4·65
(Kcal)	1550	1530	1450	1960	2020	1110
Protein (g)	9	18	11	8	4	22
Carbohydrate (g)	375	361	350	412	496	254
Fat (g)	2	1	1	1	2	1
Crude fibre (g)	24	30	20	14	4	13
Ash (g)	9	13	9	6	6	11

[a] For description of foods; see Results.

A'tmet had the lowest fibre content (4 g kg^{-1}). Our findings are comparable with nutrient values reported by others, except that the carbohydrate content, and therefore also the energy value, was lower and that the protein content was higher in the samples described here (Table 4).

Consumption

Data on the yield of ensete might indicate the relative consumption of the various ensete foods. The yield of plants harvested in the usual way on average consisted of 63% of lighter coloured and 31% of darker coloured pulp, and 6% of a'tmet. This distribution, however, varies greatly with availability of land and manure. Also, rich households often sell tikuree'ye and might buy additional a'tmet, and in summer preparation of freshly harvested corm is practised in poorer households who are in short supply of fermented pulp.

Table 5 presents the results of the dietary survey. The proportion of total energy intake derived from protein, carbohydrate and fat was 11, 82 and 7%, respectively. The average consumption of ensete foods was 0·55 kg day^{-1}, providing 78% of total carbohydrate intake but only 20% of total protein intake. The intake of energy was very low (60% of requirement) while the intakes of protein (107%), vitamin A (113%), iron (175%) and calcium (140%) exceeded the requirements. All vitamin A came from sources other than ensete, principally kale and cheese, as ensete contains no (pro)vitamin A.

TABLE 4
Composition of foods prepared from ensete expressed per kg fresh weight

Food	*Ko'cho (wu'ssa)*[a]					*Bu'lla (a'tmet)*			
	Present study[b]	*ICNND (1959)*	*Ågren (1968)*	*ENI (1980)*	*ENI (1981)*	*Present study*[b]	*ICNND (1959)*	*Ågren (1968)*	*ENI (1981)*
Moisture (g)	580	563	553	617	487	488	437	484	549
Energy (MJ)	6·46	8·48	7·35	6·34	8·40	8·46	9·41	8·32	7·14
(kcal)	1550	2030	1760	1520	2010	2020	2250	1990	1710
Protein (g)	12	12	8	9	6	4	3	10	2
Carbohydrate (g)	370	413	427	367	490	496	554	480	444
Fat (g)	2	2	1	3	1	2	1	2	1
Iron (mg)	NA[c]	53	35	36	37	NA	77	24	26
Calcium (g)	NA	1·20	1·11	0·75	0·82	NA	0·44	0·83	0·41
Crude fibre (g)	26	NA	21	11	12	4	NA	18	3

[a] General name with Guragegna name in parentheses.
[b] Weighted average: two-thirds of the food obtained from ensete was 'me'chee' and one-third was 'tikuree'ye', see Results and Table 3.
[c] Not available.

TABLE 5
Intake of energy and nutrients in Gurage

	Proportion of requirement (%)[a]	*Contribution of ensete to total intake* (%)
Energy	60[b]	68
Protein	107[b]	20
Carbohydrate	—	78
Fat	—	11
Vitamin A	113[c]	0
Iron	175[c]	28
Calcium	140[d]	65

[a] Proportion of requirement of households as a whole based on recommendations for individuals.
[b] FAO/WHO/UNU (1985).
[c] FAO/WHO (1988).
[d] WHO (1974).

DISCUSSION

Cultivation and harvesting

Few quantitative data on the cultivation of ensete are available. Estimates for the area allocated per plant range from 4 to 20 m^2 (Simmonds 1958; Stanley 1966 Bezuneh 1971). The Gurage generally plant their ensete rather densely, not more than 2 m apart, giving each plant about 4 m^2. If the data in Table 1 are used and a 6 years cutting cycle is taken into account, the average area per plant in the studied area appears to be greater: 5·8 m^2. This may be an overestimation because minor areas used for the cultivation of coffee, ch'at or oranges were sometimes included in the total area paced. Bezuneh reported two largely differing estimates for the number of plants a household dependent on ensete cultivates: 200–400 plants (Bezuneh and Feleke 1966) and 500–750 (Bezuneh 1971). Considering a 6-year cutting cycle and 4·5 persons per household (OPHCC 1989), the second estimate seems too high as it provides more than 20 plants per person per year.

The brief descriptions of the cultivation and harvesting of ensete published previously (Huffnagel 1961; Straube 1963; Bezuneh and Feleke 1966; Stanley 1966; Selinus *et al* 1971) are not consistent with another nor with our findings. According to Straube (1963) 2- or 3-year old plants are used for propagation, while the Gurage used only 4-year-old plants. He also described stages of growth lasting three years, which is longer than in the present study. Bezuneh and Feleke (1966) reported that, with average temperatures of 16–20°C, 3 years passed from planting in the permanent field until harvesting. Probably because of the higher average day temperature (23–25°C) in the Gurage area this stage of growth usually lasted only 2 years. Straube stated that, if the owners can afford it, the plants are harvested *after* flowering. In the Gurage area harvesting takes place before flowering, because flowering is said to decrease the food value of the plant markedly. Such a depletion would result from the depletion of carbohydrate stores during the flowering process. Instead of putting the non-fermented, fresh pulp in earthen pits, as is practised in Sidamo (Straube 1963), the Gurage always allow the freshly scraped pulp to ferment above ground first.

Yield

Ensete is grown in several regions of Ethiopia (Westphal 1975) which are the most densely populated (CSA 1986). This has been noticed by earlier investigators (Smeds 1955; Simmonds 1958; Straube 1963; Shack 1966; Stanley 1966; Bezuneh 1971). Thus, Smeds, Shack and Stanley concluded that ensete gives a higher yield per unit of land than other crops such as seed-crops. This has never been verified. An estimate given by the Central Statistical Office for 1967–1968 of 2·4 tons of edible ensete per hectare (cited in Bezuneh 1971), suggests that yield of ensete is only slightly higher than of cereals, and even much lower than of other common food crops such as Irish potato and sweet potato. We measured and calculated that yield of ensete (9·5 tons ha^{-1} per year) was four times the yield given by the Central Statistical Office. Because our figures are based on weighing, pacing and counting it can be assumed that they are relatively reliable. Information on the number of plants harvested by each household annually was not obtained by observation but by questioning, and might therefore be our least reliable data.

The presence of Attat Hospital may have had its influence and could possibly make our figures less representative for the Gurage area as a whole. A number of people in the area earn money by working in the hospital and therefore may have more cattle and readier access to manure which could result in higher yields. Be that as it may, it would still appear that yield of ensete, compared to that of sweet potato and to all of the cereals grown in Ethiopia, in terms of both energy and protein, is high (Table 2).

The production of the 'luxury' food a'tmet involves further refining of freshly harvested pulp. During this process a starch-rich fraction is extracted from the fibrous me'chee pulp. The more the pulp is rinsed in this process, the less starch remains behind in the pulp, decreasing its nutritional value. Therefore it is not usual to produce as much a'tmet as possible, especially in those households with limited production of ensete. The yield of a'tmet varies greatly indeed; from 0·3 to 3·8 kg per plant in our four observations. One should realise that yield of a'tmet does not say much about the quality of ensete plants, but *maximum possible yield* of a'tmet would be a valid measure for this purpose.

Ensete cultivation should be discouraged on slopes without adequate soil protection. Intercropping,

decreasing the danger of erosion and increasing productivity, should be encouraged. It has been suggested to promote cultivation of cassava in areas prone to famine. Cassava indeed gives a high yield of energy and protein but, because of its sensitivity to low temperatures, it cannot be grown in the highlands. There ensete could contribute significantly to household food security because it has a high energy yield, its food can be stored for up to several years, it is readily available throughout the year, and can withstand dry periods (Bezuneh and Feleke 1966) because of its water reserves (Stanley 1966). In areas where it already is a co-staple food and where ample fertiliser is available, the contribution of ensete to total food intake could be increased. In addition, ensete could be introduced slowly to other areas, especially in those adjacent to where it is already grown for consumption.

Preparation

The scarce information available on the preparation of ensete was reviewed and reproduced here where it differs from our findings. According to Bezuneh and Feleke (1966), parts of the stem and corm are usually cooked fresh. We observed, as did Huffnagel (1961) and Selinus *et al* (1971) that this is only done in summer when food is in short supply. Bezuneh and Feleke (1966) also stated that the fermented pulp is mixed with spices and butter before baking, whereas in the Gurage area spices are added only after baking. Although the latter study cited was carried out about 30 years ago, it was conducted in Welkite and Wolliso which are near to the area of the present study. In studies carried out in eastern Sidamo stretching back to 1844 (see Smeds 1955), consumption of young shoots, the medulla of the inflorescence, seed contents and also the fruit itself was reported. Nowadays, the Gurage do not eat these plant parts.

Food value

The main features of ensete foods are their high energy value coming almost entirely from carbohydrate and their low protein density. A daily energy requirement of 8·4 MJ for an adult can be obtained from 1·3 kg of ensete but 4·6 kg has to be consumed to reach a protein intake of 55 g. Since young children in particular cannot eat large quantities, the low protein density of ensete makes it difficult for them to obtain sufficient protein from a diet comprising only ensete. The protein content of ensete reported here is comparable to or somewhat higher than that reported from other studies (Table 4). Remarkable are the findings of Besrat *et al* (1979). They measured the protein content of 29 ensete cultivars and found an average of 33 g kg^{-1} which is much higher than that reported from other studies.

Bu'lla (a'tmet) is a food that is appreciated for its fine structure and taste. It indeed contains less fibre than other ensete foods (Tables 3 and 4). Ko'cho (wu'ssa) is not so much appreciated by those not accustomed to it because of its fermented smell and taste and its fibrous structure. As far as the fibre content of ko'cho is concerned, this is similar to that of teff enjera (11 g kg^{-1}, ENI 1981). It is possibly the structure of the fibre that contributes to its organoleptic properties. If bu'lla really stimulates healing of bone fractures, as stated by the Gurage, its calcium content would be expected to be high. However, it contained only half the amount of calcium as ko'cho (Table 3). Enjera from barley, maize, wheat and white sorghum do contain less calcium, but enjera from teff and especially finger millet has much more (ENI 1980a).

Consumption

The contribution of carbohydrate to total energy intake was 82%; somewhat lower than the 90% reported by Selinus *et al* (1971) for Sidamo Region. Also the average daily intake of ensete was lower in the present study (0·55 kg versus 0·80 kg); This difference may reflect the worsening food situation in the country as a whole due, among other reasons, to the high rate of population increase which is 2·9% per year (OPHCC 1984). The total intake of energy was only 60% of requirements. Such low energy intakes have been reported from other studies in the same region (ENI 1980b) while in Sidamo Region energy intakes are higher (Selinus *et al* 1971; ENI 1980b). The low energy intake and possible adaptation to it are the topics of a number of studies presently under way. The intakes of protein, vitamin A, iron and calcium from all food sources were well above requirements. Foods other than ensete, particularly kale (*Brassica carinata*) and cheese, provide most of these nutrients. This could explain the low prevalence of vitamin A deficiency and nutritional anaemia found in the area (Wolde-Gebriel *et al* 1993).

While evaluating the intake of iron a specific feature of the households studied has to be considered. The dietary survey was conducted in the framework of a study on nutritional anaemia, and therefore only households with an anaemic boy were chosen. Thus, iron intake could be expected to be lower than that in the general population. However, even in these households intake of iron exceeded the requirements by 75%. Results from a follow-up study in the same area indicated that infection with malaria and intestinal parasites could explain the increased prevalence of anaemia (Wolde-Gebriel *et al* 1993).

A wide range of estimates of the number of ensete plants consumed per person annually has been reported: 3 by Wohlenberg in 1936 as cited in Smeds (1955), 9 by Stanley (1966), 10 by Shack (1966), 12 by Smeds

(1955), 10–12 by Bezuneh and Feleke (1966), 12–15 by Shack (1963), and 15–20 by Huffnagel (1961). Taking into account a yield of ensete food of 34 kg per plant (Table 1) and a daily consumption of 0·55 kg ensete, it can be calculated that the number of ensete plants consumed annually is 5·9 per person or 36 per household which on average comprise 6·1 persons. The discrepancy with the reported 46 plants harvested annually per household could possible be explained by household sales. At present, each household cultivates about 0·16 ha with ensete. In order to increase energy intake to an acceptable level, this area should be increased to 0·27 ha per family assuming that the proportion of ensete to total energy intake remains the same. Other authors have considered that even larger areas are necessary even when disregarding the possible contribution to energy intake from other foods. Stanley (1966) suggested that 0·42 ha would be sufficient for an average family while Shack (1966) suggested that one hectare is needed to support a household of five to 10 members. Based on the population density in the area of 135 persons km^{-2} (CSA 1986), the proportion of land under ensete cultivation is now 3·8%. The area devoted to staples will need to be increased if the low intake of energy is to be improved.

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REFERENCES

Acland J D 1971 *East African Crops.* Longman, London, UK, pp 9–16, 33–38.

Ågren G, Gibson R 1968 *Food Composition Table for use in Ethiopia 1.* Children's Nutrition Unit, Addis Ababa, Ethiopia and Institute of Medical Chemistry, University of Uppsala, Sweden, p 5.

Besrat A, Mehansho H. Bezuneh T 1979 Effect of varietal difference and fermentation on protein quantity and quality of ensete. *Nutr Rep Int* **20** 245–250.

Bezuneh T 1971 The role of Musacae in Ethiopian agriculture. I. The genus Ensete. *Acta Hort* **21** 97–100.

Bezuneh T, Feleke A 1966 The production and utilization of the genus Ensete in Ethiopia. *Econ Bot* **20** 65–70.

Cheesman E E 1947 Classification of the bananas. *Kew Bull* **2** 97–117.

CSA 1986 *Ethiopia, Statistical Abstract 1986.* Central Statistical Authority, Addis Ababa, Ethiopia p 22.

ENI 1980a *Ethiopian Traditional Recipes.* Ethiopian Nutrition Institute, Ministry of Health, Addis Ababa, Ethiopia, pp 66–72.

ENI 1980b *First Round Nutrition Survey. October 1980.* Ethiopian Nutrition Institute, Addis Ababa, Ethiopia, p 25.

ENI 1981 *Expanded Food Composition Table for use in Ethiopia.* Ethiopian Nutrition Institute, Addis Ababa, Ethiopia, p 14, 59.

FAO/WHO/UNU 1985 *Energy and Protein Requirements.* World Health Organization, Geneva, Switzerland, pp 133–137.

FAO/WHO 1988 *Requirements of Vitamin A, Iron, Folate and Vitamin* B_{12}. Food and Agriculture Organisation, Rome, Italy, pp 25, 46.

Gashe B A 1987 Kocho fermentation. *J Appl Bacteriol* **62** 473–477.

Huffnagel H P 1961 *Agriculture in Ethiopia.* FAO, Rome, Italy, pp 24, 156–157, 250–251, 283–293.

ICNND 1959 *Ethiopia. Nutrition Survey.* Report, Interdepartmental Committee on Nutrition for National Defense, Washington, DC, USA, p 54.

Kirk R S, Sawyer R 1991 *Pearson's Composition and Analysis of Foods.* Longman Group Limited, Harlow, Essex, UK, p 13, 26–28.

OPHCC 1984 *Ethiopia 1984. Population & Housing Census Preliminary Report.* Office of the Population and Housing Census Commission, Addis Ababa, Ethiopia, pp 20, 24–26, 28.

OPHCC 1989 *Population and Housing Census 1984. Analytical Report on Shewa Region.* Office of the Population and Housing Census Commission, Addis Ababa, Ethiopia, p 47.

Selinus R, Gobezie A, Vahlquist B 1971 Dietary studies in Ethiopia. III. Dietary pattern among the Sidamo ethnic group. A study on villagers in the ensete monoculture area in S. Ethiopia with special attention to the situation in young children. *Acta Soc Med Upsalla* **76** 158–178.

Sevenhuysen G P, Schuppel R W 1989 *MicroNAP. Nutrient Analysis for Research Purposes. User Guide Version 4·21.* University of Manitoba, Winnipeg, Canada.

Shack W A 1963 Some aspects of ecology and social structure in the ensete complex in South-west Ethiopia. *J R Anthrop Inst* **93** 72–79.

Shack W A 1966 *The Gurage, A People of the Ensete Culture.* Oxford University Press, London, UK, pp 50–82.

Simmonds N W 1958 Ensete cultivation in the Sourthern Highlands of Ethiopia; a review. *Trop Agric Trinidad* **35** 302–307.

Smeds H 1955 The ensete planting culture of eastern Sidamo, Ethiopia. *Acta Geog Helsingf* **13** 1–39.

Stanley S 1966 Ensete in the Ethiopian economy. *Ethiopian Geog J* **4** 30–37.

Straube H 1963 *Völker Süd-Äthiopiens 3: Westkuschitische Völker Süd-Äthiopiens.* W Kohlhammer Verlag, Stuttgart, Germany, pp 88–96, 296–301.

West C E, Pepping F, Temalilwa C R 1988 *The Composition of Foods Commonly Eaten in East Africa.* Wageningen Agricultural University (on behalf of CTA and ECSA), Wageningen, The Netherlands, pp 14, 22.

Westphal E 1975 *Agricultural Systems in Ethiopia.* Pudoc (Centre for Agricultural Publishing and Documentation), Wageningen, The Netherlands, pp 123, 164.

WHO 1974 *Handbook on Human Nutritional Requirements.* World Health Organization, Geneva, Switzerland, pp 68–69.

Wolde-Gebriel Z, West C E, Gebru H, Tadesse A S, Fisseha T, Gabre P, Aboye C, Ayana G, Hautvast J G A J 1993 Interrelationship between vitamin A, iodine and iron status in schoolchildren in Shoa Region, Central Ethiopia. *Br J Nutr* **70** 593–607.