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FINAL TECHNICAL REPORT FOR THE PROJECT

Project Title:

IMPROVING THE PRESERVATION, MARKETABILITY AND UTILISATION OF TRADITIONAL GHANAIAN LEAFY VEGETABLES FOR USE AS SOURCES OF MICRONUTRIENTS

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Executing Institution:

FOOD RESEARCH INSTITUTE (CSIR), BOX M. 20, ACCRA, GHANA

Collaborating Institutions:

International Plant Genetics Resources Institute (IPGRI), Rome, Italy
Savannah Agricultural Research Institute (CSIR), Box 46, Tamale, Ghana.
Crop Research Institute (CSIR), Box 3785, Kumasi, Ghana.

Project Manager:

Dr P-N. T Johnson, Food Research Institute, Box M. 20, Accra, Ghana.
Tel: 233-21-777330/ 500470
Fax: 233-21-777647
e-mail: fri@ghana.com OR panijohnson@idngh.com

Executive Summary

This is a baseline report on some of the traditional leafy vegetables (TLVs) used in Ghana. *Amaranthus* spp., *Corchorus* spp. and *Hibiscus sabdarrifa* occupy between 50 – 60 % of land allocated for vegetable cultivation in the study areas in the dry-savannah parts of Ghana. Production, however, suffers from lack of planting/high-yielding seeds, weeds, insect pests and lack of official research and development supports. Post-harvest management is poor in most places. With the high rate of wilting and the lack of appropriate storage techniques, the resulting poor keeping quality of all three TLVs is one of the biggest worries of almost all the farmers. Sun drying was the only preservation technique employed to improve shelf lives. Unfortunately, this was done mainly on uncemented floors where rodents and domestic animals like goats, fowls and sheep have easy access.

Consumer preference for the three TLVs varied from place to place. Whilst at the Kumasi Central Market, the order of marketability of the three TLVs, used as a proxy for consumer preference, was *Corchorus* spp >*Amaranthus* spp> *Hibsicus sabdariffa,* the order, however, reverses at the Tamale Central Market. Unlike the latter market, the three TLVs were poorly integrated into the mainstream marketing of vegetables at the Kumasi Central Market. The marketing of TLVs had an unfortunate socio-cultural bias. Different ethnic groups specialised in the sale of TLVs that are preferred by their communities. At most markets in the south, whilst the marketing of the leaves of cocoyam, *Xanthosoma maffafa,* the most popular TLV in the forest zone, is widespread, that of the three popular dry-savannah TLVs was limited and handled mainly by traders of northern Ghana descent. Market women from the south wrongly perceived these TLVs as weeds; a major obstacle to the general use of these TLVs.

When the three TLVs were minimally processed, sealed-packaged in low-density polyethylene bags, with perforations, and stored at 5-8 °C and 80-85 % RH for a period of 18 days, the order of increasing shelf-life obtained for the three TLVs was; *Hibsicus sabdariffa* (3 days), <*Amaranthus viridis* (by 6 days) and *Corhorus olitorius* (by 10 days). Though most households in the north consume these leaves about 4 to 5 times in a week, the drudgery and cumbersome processes involved in the using these TLVs in the preparations of traditional dishes as well as the undesirable sensory characteristics such as the taste, especially if not well cooked, were identified as the main obstacles to increased use of the TLVs. Initial traditional parboiling of the leaves before being used resulted in considerable losses of micronutrients. The worst was *Corhorus olitorius,* which lost 15 % vitamin A, 40 % of vitamin C, 20 % of iron and 40 % of zinc when parboiled for 30 minutes and water strained off. Though solar dehydration considerably reduced drying time and microbial load, it affected micronutrient retention ratio, colour and therefore, general quality of the TLVs.

TLVs from the dry-savannah parts of Ghana are not widely used in the cities of Ghana.. Only 10 % of respondents (n= 200) of the two major cities in Ghana claim to be using the TLVs occasionally. This means that there is an urgent need to create national awareness of the nutritional values of these TLVs.

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1. BACKGROUND

This project sought to gather baseline information on the position and role of some traditional leafy vegetables in the socio-economic development in Ghana, as well as develop a concept note for a project to improve the micronutrient contents of the diets of Ghanaian families through improvement in the production, keeping qualities, marketing and utilisation of some of traditional leafy vegetables. There is the need for such a project because of disturbing high levels of micronutrient malnutrition among the resources-poor in Ghana. It is estimated that between 1980 and 1987, 28 % of the 12 – 23 months old, 31% of 24 – 59 months old babies and 30 % of all children under the age of 5 years were either considered malnourished and/or stunted. The number of children with chronic malnutrition conditions is more in the northern, dry savannah ecozones than in the forest and coastal parts of Ghana (Agble 1992 and Quarshie & Agble 1999).

A number of factors are responsible for the micronutrient malnutrition of most Ghanaians. The main cause of micronutrient deficiency is inadequate intake of foods rich in micronutrient. Another factor responsible for the micronutrient malnutrition is that most staple diets of majority of the resource-poor people in sub-Sahara Africa are primarily made from whole-grain staples. These staples usually have anti-nutritional factors that inhibit the absorption of some essential micronutrients. For example zinc deficiency is prevalent not only because such whole-grain staple diets are low in zinc, but also because the high phytate content of whole-grain tends to inhibit zinc absorption from the gut (FAO, 1992).

An additional factor could be traced to the traditional methods of cooking which destroy the water and heat-labile vitamins (Ihekoronye & Ngoddy, 1985). For example though folic acid is contained in a variety of foods, particularly raw dark-green leafy vegetables, it is, however, unstable when heated in neutral or alkaline conditions. Traditionally, the most leafy green vegetables are usually cooked for a long time before use in most diets of African dishes.

For the poor in sub-Saharan Africa, dietary improvements are considered to be one of the most cost-effective methods of addressing such problems. Dietary improvements should aim at increasing the availability and consumption of food rich in micronutrients. One of the cheapest yet rich sources of essential micronutrients are vegetables, especially traditional leafy vegetables (TLVs). TLVs contain vitamins and minerals such as vitamin A, thiamine, riboflavin, ascorbic acid, niacin, and minerals like calcium, iron, zinc, magnesium and phosphorus (Eyeson & Ankrah 1975).

In a recent survey conducted in five African countries by a number of scientists, though TLVs were found to be very important in the food culture of most Africans, the need was established for further studies to make the TLVs easier to cook, transport and process so that they can be competitive in the urban market (Chweya & Eyzaguirre 1999). A large variety of highly nutritious TLVs, such as *Amaranthus* spp., *Talinium* spp., *Basella* spp., *Colocasia esculenta*, *Sesamum* spp., *Corchorus* spp., *Hibiscus* spp.,

Ma*nihot esculenta* and *Telfaira occidentalis* (Abbiw, 1990), are known to be available and used in some cultures. Unfortunately, access to adequate quantities of most of these nutritionally valuable leafy vegetables is not guaranteed. This is because the existing potential for the cultivation and intensive use of TLVs is not being adequately utilised because of a number of reasons. The key one being that there is a gradual loss and/or lack of interest in indigenous knowledge about preparation and utilization methods of traditional vegetables. This is because the younger generations in most developing countries erroneously think the TLVs are inferior to the exotic vegetables. Also very little research and extension have been carried out to improve the production, preservation and utilization. It is a known fact that most government agricultural departments have very little in terms of actual work carried out or being carried out to improve the productivity of TLVs. Consequently apart from the gradual erosion of genetic data on these TLVs, methods for preservations and utilizations are not being improved to help attract the patronage of the TLVs by urban dwellers. As with almost all perishable crops, the nature of the marketing systems and distribution channels can dictate how successful preserved forms of TLVs will reach the urban consumer. Additionally, development of new recipes will increase the utilization of fresh and/or dehydrated TLVs.

2. PROJECT DESCRIPTION

2.1 Project purpose

The purpose which this project contributed to was '*Strategies to improve the micronutrient contents of diets of Ghanaian families through improvements in the keeping qualities, marketing and utilization of priority traditional leafy vegetables which are rich sources of micronutrients'*. The objective of this study was undertake a pre-feasibility research study to generate baseline technical and socio-economic information on some important Ghanaian TLVs, which are rich sources of micronutrients, with the view to developing a concept note for major research and development interventions to address the constraints identified.

2.2 Project Objectives

These were:

- To gather baseline information on production areas, patterns and constraints, traditional preservation methods and utilisation of the priority traditional leafy vegetables (TLVs) found in the forest and dry savannah agro-ecological zones in Ghana.

- To identify and examine the marketing system, tracing the distribution channels and determining profit margins, gender issues and establishing the seasonality of prices of the selected TLVs.

- To investigate the effects of simple processing techniques; minimal processing, packaging and solar-dehydration on the micronutrients contents and keeping qualities of selected TLVs.
- To assess the extent of use and perceptions of the selected priority TLVs among urban settlers in Ghana.

2.3 Research Activities and Methodology

The research activities carried out and the methods used are briefly described against the outputs 1-4.

Output 1: Documentation on the baseline information on production, socio-economic factors, traditional preservation techniques and utilization of priority traditional leafy vegetables (TLVs) in the dry-savannah and forest ecozones of Ghana.

Two activities were undertaken to meet this output. These were;

i. Identify and select two towns/villages each from the dry savannah and forest ecozones in Ghana where TLVs play major roles in the farming systems, food culture and socio-economic activities.

This activity was carried using rapid rural appraisal (RRA) method (Nabasa *et al* 1995). It was carried with the assistance of undergraduate agricultural students of the University of Ghana and who come from the Northern Region of Ghana. They were assisted by field officers of District Agricultural Directorates in the three northern regions of Ghana. The checklist used is given in Annex 1.

ii. Identify production patterns, constraints, coping strategies, preservation techniques and utilization of TLVs in the selected towns/villages and assess the gender roles.

This activity was carried using participatory rural appraisal (PRA) method (Nabasa *et al.* 1995). It was carried out by a multi-disciplinary team comprising of two agronomists, a horticulturalist/entomologist, two socio-economists, a food technologist and a home scientist/ nutritionist. The experts came from the Food Research Institute, the Savannah Agricultural Research Institute, in Tamale and the Crop Research Institute in Kumasi. The checklist used is given in Annex 2.

The study covered the biophysical and socio-demographic features of the study areas, as well as the agronomy. It further looked at the post-harvest arrangements; traditional

preservation and storage facilities. The socio-economic factors and marketing were also considered.

The study on the utilization of the TLVs covered an assessment of the relative preference, perceptions about the TLVs and traditional nutritional knowledge. The study also looked at the methods used in the preparation of the TLVs, proportions and mode of use in staple diets, as well as obstacles to increased use of the TLVs.

The PRA team assisted the farmers and their wives to quantify their preferences for as well as the respective sensory attributes of the different TLVs (Plates 1 & 2, Annex 3). Selected sensory attributes of the popular TLVs such as taste, slipperiness/non-slipperiness, aroma and mouth-feel were assessed over a total score of 5; as 5= like very much; 4 = like moderately/slightly; 3 = neither like nor dislike; 2 = dislike slightly/moderately and 1= dislike very much.

It also extensively looked at secondary data, especially research and development work carried out on the production, preservation, marketing and utilisation of TLVs in Ghana and other West African countries.

Output 2: Documentation on the marketing systems and distribution channels of the TLVs

The main activity carried out was:

i. *Identify the marketing systems, distribution channels in the selected towns and determine the profit margins and establish the seasonality of prices.*

The marketing systems and distribution channels as well as the profit margins for the three TLVs were carried out at the three main markets in Tamale (Central, Aboabo and Lamashegu) and Kumasi Central Market. Informal interviews were conducted by a team of post-graduate students with the assistance of the two socio-economists on the project. A simple random sampling technique was used in selecting respondents. The checklist used for the survey is given in Annex 4.

The surveys were carried out both early in the mornings and the evenings when most vegetables traders were present at the markets. In each market, a total of twenty vegetable traders were randomly selected and interviewed on trader details, product inventory, market/post-harvest arrangements, prices and incomes, consumers' preferences, seasonality and constraints.

Output 3: The effect of using simple processing techniques; minimal processing, packaging and solar-dehydration on the micronutrient contents and the keeping qualities of the three TLVs established.

Three activities were undertaken to meet this output:

i. Investigate the effects of using minimal processing, packaging in low-density polyethylene with perforations at a reduced temperature (6 ± 1 °C) and high humidity (83 ± 2 % RH) on the keeping qualities of the three selected TLVs.

This activity was carried to test the hypothesis that since the three TLVs were very active and respired at a high rate, losing a lot of water, their shelf-lives can be extended by packaging them in low density polyethylene pouches and storing under conditions of low temperature and high humidity.

Five kilograms each of freshly harvested *Amaranthus viridis*, *Corchorus olitorius* and *Hibiscus sabdarrifa* were purchased and washed thoroughly with running tap-water to remove soil particles, dirt, etc. After washing the leaves were cut off the stems with a clean, sterilised scissors and again washed in plentiful water. The TLV obtained ranged between 65-70 % of the original weight. 150 g samples were sealed-packaged in low-density polyethylene (LDPE) pouches with ten perforations. Quality parameters, assessed by a trained panel of ten and monitored over a period of 18 days, were leaf discoloration, aroma visible decay, hand-feel, percentage marketable and overall quality impression (Langerak 1978, Risse & Miller 1982, Sherman *et al.* 1982 and Sherman & Allen 1983). Fungal and bacterial counts were also monitored.

ii. Investigate the effects of traditional parboiling on the micronutrient contents of the TLVs

Fifty grams of each of the TLVs were boiled in 1 L of distilled water for a period of 30 mins in a covered bowl. The micronutrients (vitamins A and C, iron and zinc) were determined in the fresh, parboiled leaves and as well as the amounts leached out into the boiling water, using standard AOAC methods (1990).

iii. Investigate the use of solar dehydration as a preservation technique for the three TLVs

Drying tests were carried out between October – December, 2000, using a box solar dryer with drying floor measuring 730 x 1230 mm. The freshly harvested TLVs brought from the field were washed, steam blanched and then, about 2 kg samples of the leaves were loaded on the trays in thin layers of about 6 mm. Trays were placed in the solar dryer when the latter attained a temperature of about 55 °C. Samples of the leaves were also dried under a shade at ambient condition to serve as the control to the experiment. The drying conditions and the time for the leaves to dry to the equilibrium moisture content, as per conditions of the drying were monitored.

Chemical analysis of the dried leaves was carried out. Samples of the dried leaves were also sealed-packaged in LDPE pouches and stored at 30 ± 2 °C and 75 ± 1% RH for 24 weeks. During the storage period, moisture uptake, colour changes, micronutrient retention ratio and microbiological status were monitored at 3-week intervals, using standard AOAC (1990) methods.

Output 4: The extent of the present use and perceptions about the three TLVs from the dry-savannah ecozone among cities dwellers in Ghana assessed.

This output replaced the one on developing new recipes for TLVs, as proposed in the original project proposal. This replacement became necessary following evidence of problems with the utilization of the TLVs as established through the PRA carried for output 1. Only one activity was carried out to meet this output.

Assess the extent of use and perceptions city dwellers in Ghana hold about Amaranthus* spp., *Corchorus olitorius* and *Hibiscus sabdariffa

Annex 5 gives the questionnaire administered.

2.4 Outputs-Results & Discussion

Fig. 1 (Annex 6) shows the study areas for this project.

2.4.1 Output 1

2.4.1.1 Dry-savannah Ecozone

The towns selected for PRA in the dry-savannah (Fig. 2, Annex 7) and the production characteristics of TLVs in the towns are given in Table 1 (Annex 8).

Production Patterns: At all the sites, vegetable production dominate in the dry season but in the wet season, cereal crops such as maize is found at the upper fringes and rice in the lower fringes of the dam site. Leafy vegetables such as *Corchorus olitorius* (*'ayoyo'), Amaranthus* spp (*'alefu'*), *Hibiscus sabdariffa* (roselle or *'bra')* and *Hibiscus cannabinus* (kenaf) are intercropped with the maize in the upper fringes of the dam site. However in the case of Gurugu, and Zagyuri which are not dam sites, the cereal crop planted is mainly maize intercropped with *Hibiscus cannabinus* (kenaf), *Corchorus olitorius* (*'ayoyo'*) and *Hibiscus sabdariffa* (roselle).

Other TLVs found at the study areas were leaves of cowpea (*Vigna unguiculata*; locally referred to as bengit), okro (*Ablemoshus esculentus*), cassava (*Manihot esculenta*),

pumpkin (*Cucurbita* spp.) baobab (*Adansonis digitata*), melon (*Cucumis melo*) and *Tamrindus indica*. (Table 2, Annex 9).

In the dry season at all the sites, sole vegetables such as *Corchorus olitorius* ('a*yoyo'), Hibiscus sabdariffa* (roselle), *Vigna uniguiculata* (cowpea bean) leaves, *Amaranthus* spp ('*alefu*') and *Hibiscus cannabinus* (kenaf) are produced on beds of small sizes measuring about 8 m by 5 m. While cowpea bean leaves, kenaf and roselle are uprooted for sale and could be replanted with the same vegetables, '*ayoyo*' and '*alefu*' are permanent, and only the fresh leaves are harvested from time to time for sale.

Seeds for planting are a major problem. Seeds of *Amaranthus* ('Alefu'), tomato and okra are produced on their fields and used the following year. Farmers obtained seeds of *Hibiscus* spp (kenaf and roselle) either by buying from neighbours or from the markets. This is because kenaf and roselle are harvested at tender ages for sale and are not allowed to reproduce on their fields. However some farmers grow their own seed in the preceding wet season to use in the dry season

The relative importance of the different TLVs to the inhabitants is reflected in the amount of labour used. Fig. 3 shows that more time is allotted to cultivation of *Corchorus* spp and *Hibiscus sabdariffa* than *Amaranthus* spp and the other leafy vegetables. Most of this labour is used in the harvesting of the leaves that entails picking and becomes more tedious when the leaf size reduces due to aging of the plant.

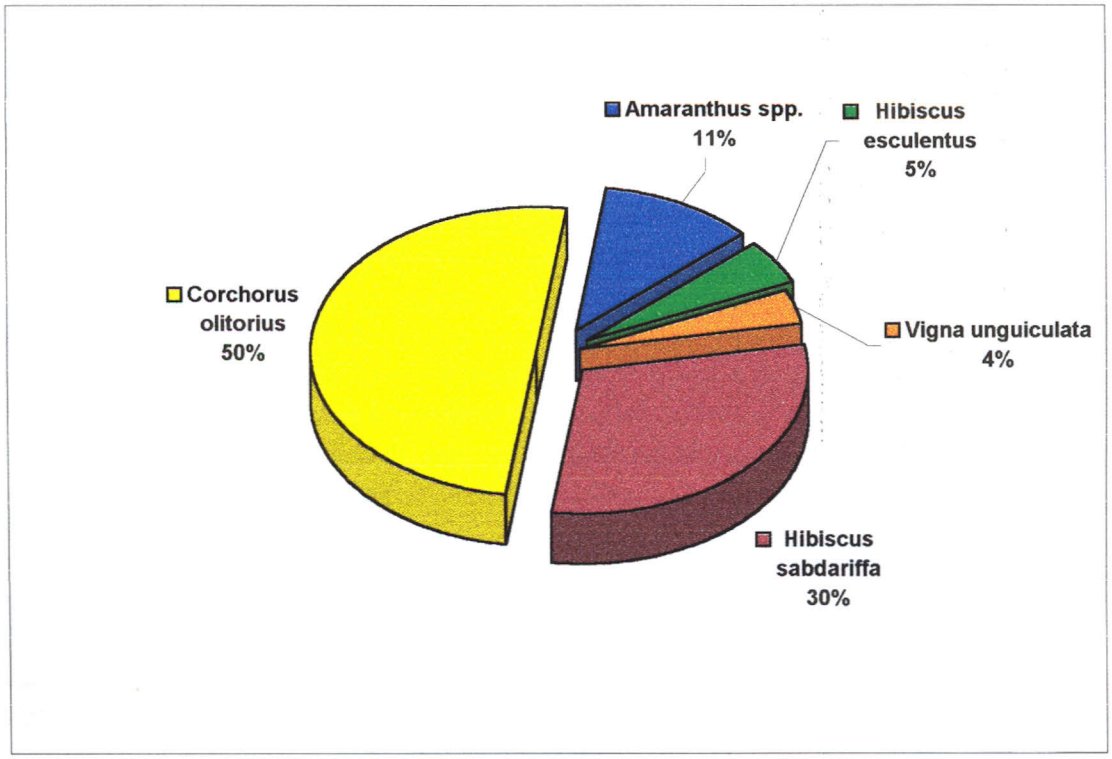


Fig. 3 Labour distribution for some TLVs at Gbulahagu, near Nyankpla, N.R

Details on the results of some research and development work carried out on the production of *Amaranthus* spp, *Corchorus* spp. and *Hibiscus sabdarrifa* have been discussed by Norman (1992).

Post-harvest Arrangements and Preservation Techniques: Harvesting was usually carried out very early in the morning with the aim of maintaining the full turgidity of the leaves. This is because transpiration is normally at a minimum during the hours of darkness and early in the day. Harvesting done at this optimum time ensures that the leaves remain fresh until they are either consumed or sent to the market. Ideally, all leafy crops should be cut from the root or removed from the stem with a sharp knife as pulling and tearing may damage the remaining plant tissues, which in some cases will produce new leaves. At Gurugu, however, the farmers harvested the leafy vegetables by tearing and pulling. This activity was performed by both sexes. Discoloured or partially insect-eaten were removed. The good quality leafy vegetables were then washed to keep them in a fresh, unwilted condition. They were then tied into bundles of a size, normally accepted on the local market, placed in basins with little water to keep the leaves fresh. Usually the leaves of *Amaranthus* spp. have to be sent immediately to the market. The uprooted whole plants of *Hibiscus sabdariffa* can, however, be stored immersed in water for about three days without withering. Beyond the third day, the leaves are plucked and dried directly in the sun. *Corchorus* spp leaves can stay fresh for about a week. The fresh leaves of these vegetables fetch more money than the dried ones.

Traditional leafy vegetable seeds were preserved in rugs to ensure aeration. However, seeds of roselle ('*bra*') lose their viability before the end of the year. *Amaranthus* spp. ('*alefu'*) seeds cannot be stored beyond a year. Apparently, they lose their viability when the weather becomes humid leading to the development of fungal growth that manifest themselves when the seeds were sown hampering germination and establishment. Securing the availability of seed for a longer period will be a boost to food security.

Even at the peak of the dry season when production is high, sometimes supplies exceed demand and therefore prices go down. Respondents wanted to be assisted to process the TLVs to be sold later or preserved in such a way as to extend the shelf life of the TLVs. Sun drying was the only traditional method of preservation being used. The survey team did not find any purpose-build places for storing the leaves, apart from finding them in the small baskets in the kitchens.

Utilisation of TLVs: TLVs are mainly used in preparing soups with a few used in preparing stews as well. These are served as a main meal with carbohydrate rich foods such as *fufu* (a pounded mash of boiled yam), *tuo zarfi* (a meal prepared from sorghum, millet or maize flour, with cassava flour), *omo tuo* (a cooked and mashed rice balls) or boiled yam or rice.

Traditionally, all the TLVs are perceived to be of high nutritional value and good for the general growth and development of the body. In terms of nutritional values, the order of

perceived quality are *Hibiscus sabdariffa*, roselle, ('bra')>*Amaranthus* ('*alefu'*) > *Corhorus olitorius* ('a*yoyo'*) in the Northern region, while in the Upper East region, *Amaranthus spp.* is considered to be he most nutritious, followed by *Corchorus* spp. Though respondents could not make factual statements about the type of nutrients in these TLVs, most felt they were very good substitutes for proteins. Table 3 gives the micronutrient contents of a number of TLVs.

Fig. 4 and 5 give the relative preferences for *Hibiscus sabdariffa* , roselle, ('*bra*')> *Amaranthus* ('*alefu'*)> *Corhorus olitorius* ('a*yoyo'*) as well as other TLVs, in the two regions.

All three TLVs are widely used in the preparation of traditional dishes. Sensory attributes which appeal to consumers depended on the type and the area. Whilst *Amaranthus* is very much liked in the Northern Region for its slipperiness, followed by its aroma, *Corchorus* spp. is liked in the same region for its taste (Fig. 6). In the Upper East Region of Ghana, however, *Corchorus* spp. is liked most for its slipperiness and mouthfeel, *Hibiscus sabdarrifa* is liked for its aroma and mouth-feel (Fig. 7).

The taste of *Amaranthus* ('alefu') as shown in the Fig. 6 was neither liked nor disliked although all other attributes were generally ranked high. The reason given was that the leaves could be very sour or bitter; especially older leaves, and this affected the taste of meals prepared with 'alefu', if care was not taken to reduce this undesirable taste. It is therefore a very important procedure during cooking to reduce this sourness/bitterness by straining off the water used in parboiling the leaves before adding to the base stew or soup. However in the Upper East Region, a higher score was obtained for 'alefu' because the respondents in the area said they liked the sour/bitter taste associated with it. It was accepted as a unique characteristic of the leaves in the Upper East region. This clearly shows a cultural diversity in taste and that should strongly influence recipe development for 'alefu'.

Mode of Use: All three important TLVs have similar modes of use in the staple diets. Roselle (*Hibsicus sabdariffa*), popular called 'Bra' is typically used only in the preparation of soups preferably with the fresh leaves. The leaves may also be dried for use. The fresh leaves are washed and then parboiled either whole or chopped for about 10 min. The water used to parboil the leaves is strained off and replaced with fresh water. Cooking is continued until well done (about 30 min). The water is changed two or three times during parboiling and this is done to reduce the sourness/bitterness in the leaves. When the leaves are well cooked, the main soup base is prepared with fresh or roasted groundnuts paste, 'dawadawa (a local condiment), fish/meat and other vegetables until well done. The main soup cooks within 1 – 1.5 h. The cooked roselle leaves are then added to the main soup base and allowed to simmer for 15 min. In the case of *Corchorus* spp., however, the leaves can be used as the main source in the preparation of the base soup.

Table 3

Micronutrient contents of some Traditional Leafy Vegetables (TLVs) found in the dry-savannah and forest zones of Ghana as obtained from literature

TRADITIONAL LEAFY VEGETABLE		MICRONUTRIENT CONTENT	
Local Name	**Scientific Name**	**(in the fresh form) in mg/ 100 g of edible fresh form**	**(in processed form) in mg/ 100 g of edible processed form**
Ayoyo (bush okro)	*Corchorus* spp	Vit C: 40.53, P: 35.36 and Fe: 21.6; Ca: 76.6 Zn: 1.76	n.a
Alefu	*Amaranthus* spp.	Vit A: 7-10.3;Vit. C: 14-37, Ca: 1.9 ; Fe:10.4;, P: 0.5; Zn: 1.16	Vit. A: 548 RE Vit. C : 14.0 mg; Ca: 2380 , Fe: 130 ; P: 0.5 (after drying) Zn: 6.7
Bra (Roselle)	*Hibiscus sabdariffa*	Vit A: Vit. C: 26.17 Ca: 738.24; Fe: 16.97	
Kenaf	*Hibiscus cannabinus*	n.a	n.a
Cowpea leaves (also called bengit)	*Vigna unguiculata*	Vit A : 5.2 – 8. 2 , Vit. C: 46 – 110, Ca: 162 –412 Fe: 5.0	Vit A: 0.7 ; Vit C : 23.0
Okro leaves	*Ablemoschus esculentus*	Vit. A : 0.1 mg; Vit C :59 mg; Thiamine: 0.25; Riboflavin: 2.8; Niacin: 0.2 Ca: 86 mg Fe: 1.0 mg	n.a
Soaka (bitter leaf)	*Vernonia amygdalina*	Ca: 145 , Fe: 5.0	Ca: 105 Fe: 5.5
Kontomire	*Xanthosoma maffafa*	Vit. C: 47.5	n.a
Baobab	*Adansonis digitata*	Vit. A: 4.9; Vit.C :trace Ca: 406 ; P: 261 ; Fe: 25	Fe: 24 Thiamine 0.13 Riboflavin : 0.82 Niacin : 4.4 Vit A: 112 Ca: 1890 Zn: 2.5
Cassava leaves	*Manihot esculenta*	Thiamine: 0.25 Riboflavin: 0.60 Niacin: 2.4 Vit C: 311 ; Ca: 300 ; Fe: 7.6; β-carotene	n.a
Pumpkin leaves	*Cucurbita* spp.	Ca: 475 ; Fe: 0.8; β-carotene:1000	n.a
	Tamarindus indica	n.a	Ca: 330; Fe: 91; Zn: 2.7

Sources: Gomez (1981), Nordeide *et al* (1996), FAO (1997); Chweya & Eyzaquirre (1999); Tayie (1989), **n.a = not available**

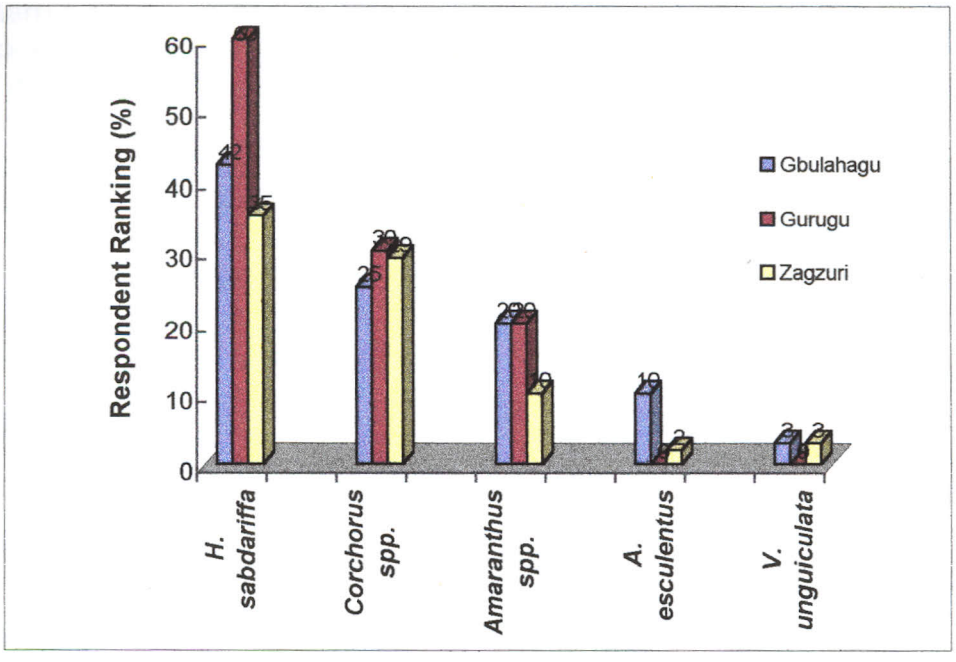


Fig. 4 Relative preference ranking for popular TLVs at three sites in the Northern Region of Ghana

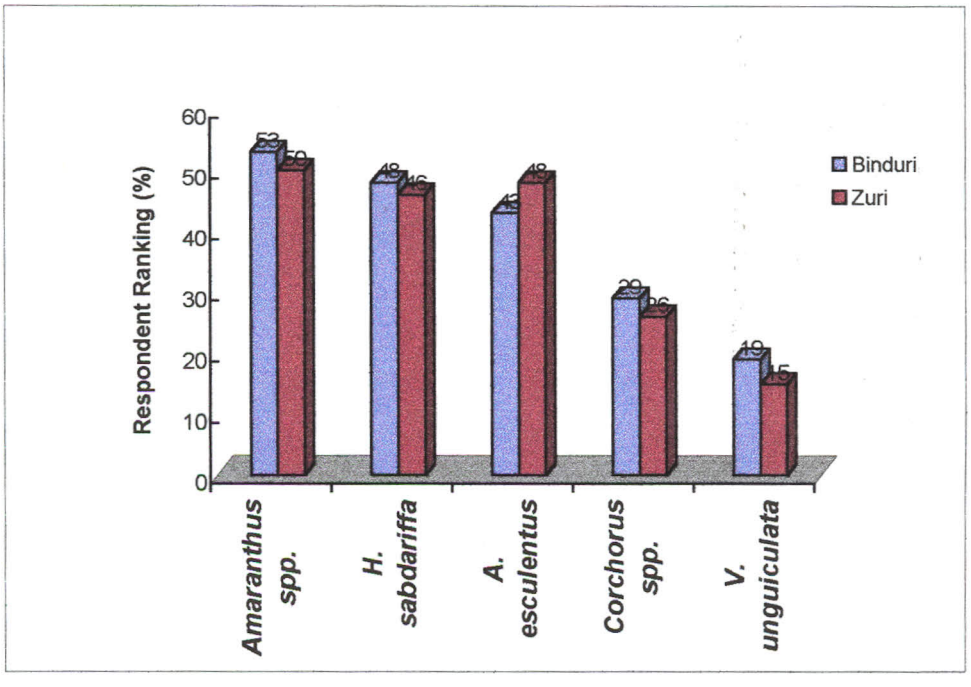


Fig. 5 Relative preference ranking for popular TLVs at two sites in the Upper East Region of Ghana.

In the Northern Ghana, *Amaranthus* spp. is similarly prepared. The cooked leaves are sometimes pounded in a mortar until smooth before being added to the stew or soup. In the Upper-East, the Amaranthus leaves are cooked for a shorter time, about 15 min.

Socio-cultural considerations: Although roselle is very popular in the Northern region, it is not cooked for strangers or visitors to a household. This is because it is believed that some tribes do not eat this leafy vegetable and therefore serving a stranger with it is avoided. The leafy vegetable is also not used for any ceremonial or religious celebrations. It is however, used in preparing meals for women who have just had

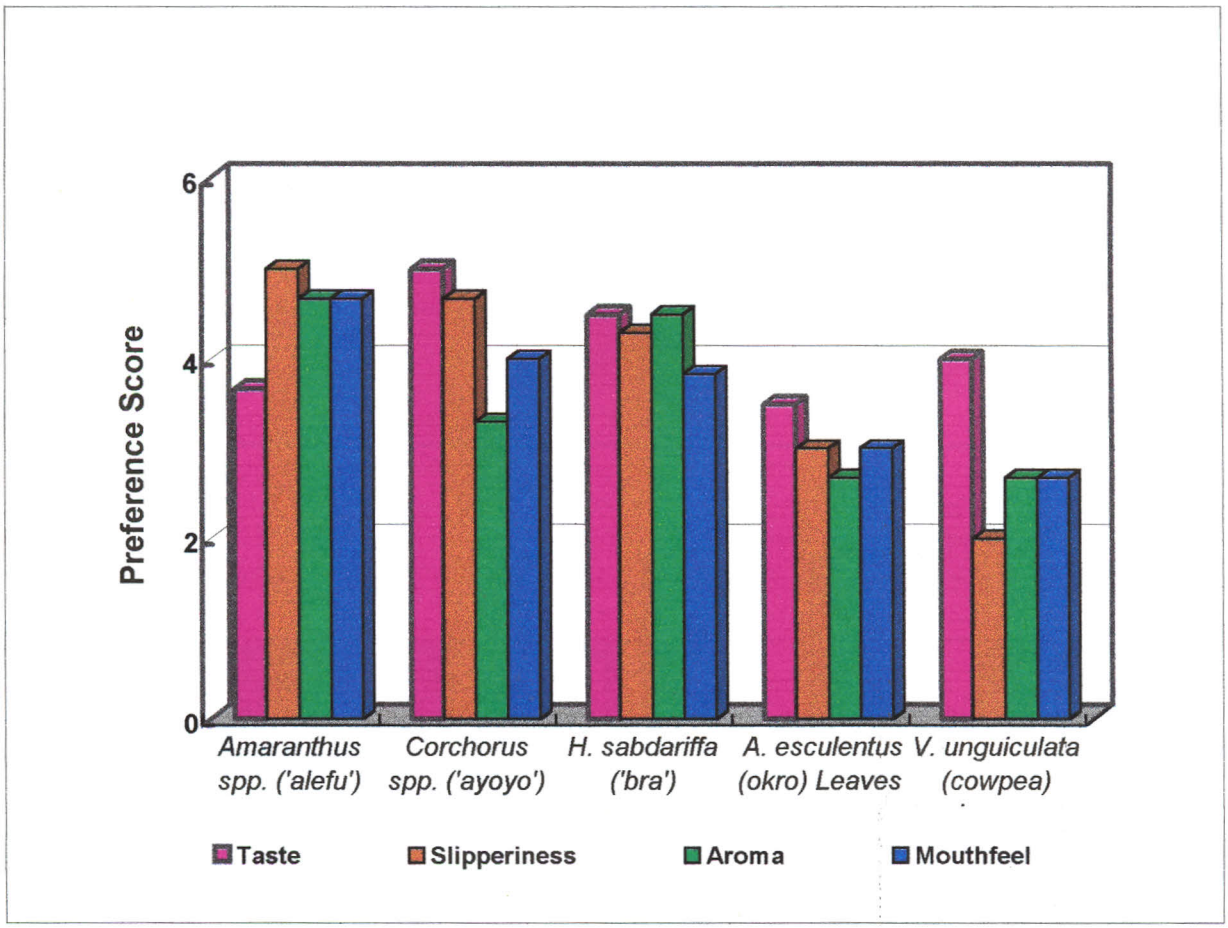


Fig. 6 **Sensory assessment of popular TLVs at three study sites in the Northern Region**

babies because it is believed that it has some medicinal values which help the women recover blood loss during delivery.

Corchorus spp. ('ayoyo') is used for ceremonial dishes, for example during weddings and child naming ceremonies.

Amaranthus spp., okra and cowpea leaves have no religious or medicinal values and are not used for any ceremonial dishes.

The seeds of roselle are ground and used to treat ulcers on the foot. The leaves are also mashed and used to treat bee stings. The leaf when smeared on the sting is believed to detoxify the poison. Juice squeezed from the flower of roselle is also used as an eardrop to treat ear pains. It is also used to treat boils in the armpit.

Comments on methods of use of the TLVs: Indications from this survey reveal that these TLVs form an important part in the diets of the people and are considered very palatable and nutritious. Although the nutritious value of these TLVs cannot be underestimated, their unpopularity in most southern sector regions of Ghana may be attributed to unavailability, poor packaging and presentation, lack of knowledge about the use and preparation of the TLVs and socio-cultural bias against these TLVs. However, popularization and awareness creation can improve the utilisation base of these TLVs, as a means of improving the nutritional status of the people, especially for those who cannot afford the 'exotic' vegetables.

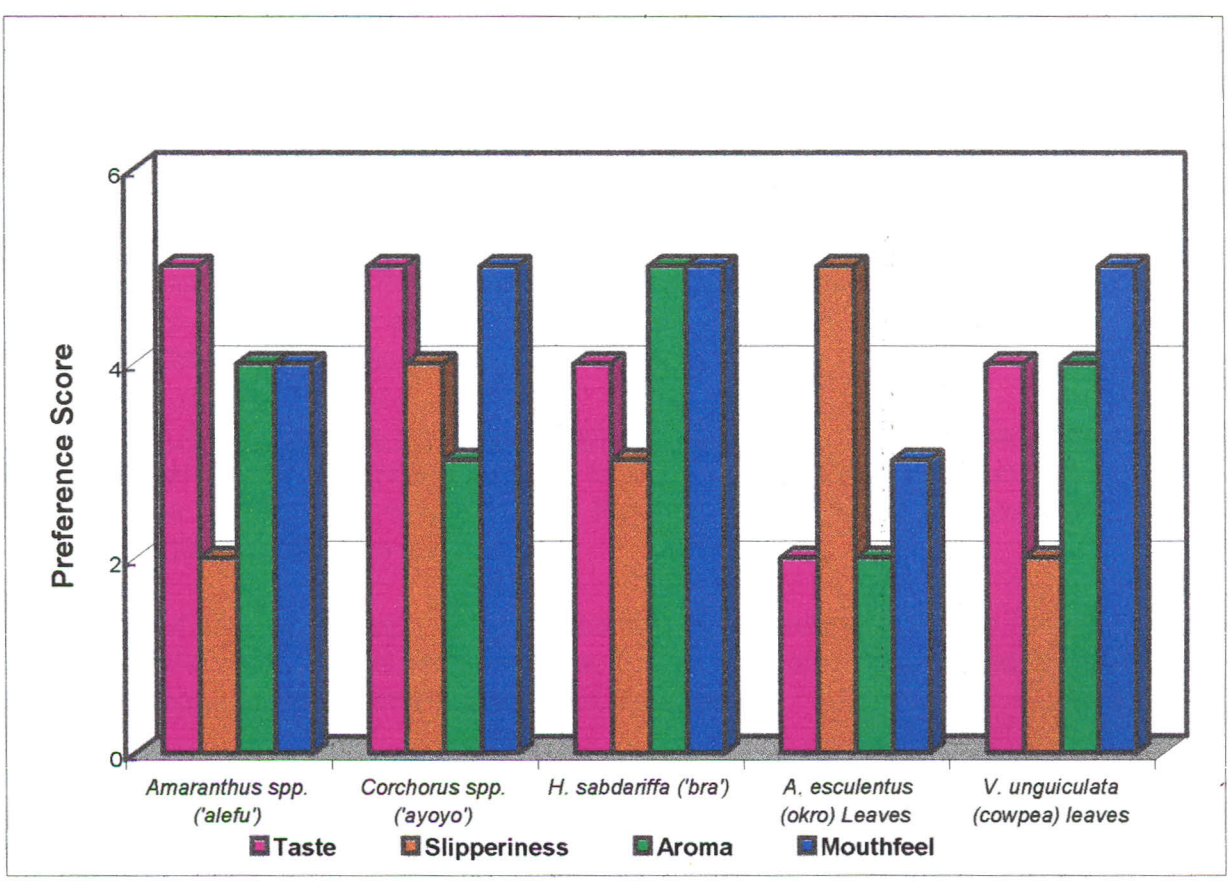


Fig. 7 Sensory assessment of popular TLVs at two study sites in the Upper-East Region of Ghana

2.4.1.2 Forest Ecozone

Three villages, Darku, Hemang and Aburaso, selected for the PRA are all in the Atwima-Kwanwoma district of Ashanti Region.

Production Patterns: The most common TLVs produced and consumed in this area are cocoyam (*Xanthosoma* spp.) leaves (locally called 'Nkontonmire'), cassava leaves, cowpea leaves, bitter leaf, *Corchorus olitorius* ,*Amaranthus* spp., water leaf (*Talinum triangulare*), also referred to locally as Bokoboko, Gboma=Leafy Garden egg (*Solanum incanum*) and Bra, Roselle (*Hibiscus sabdariffa.*)

The leaves of *Xanthosoma* spp. tend to grow both wild and as a cultivated crop. When domesticated, the leaves tend to be large and very attractive depending on the fertility status of the soil. From the wild, it is mainly a volunteer crop and probably because of crowding and competition from other plants, the leaves are small. Young leaves are usually harvested while the crop continues to grow. Because the root corms are harvested as food, some leaves need to be left to produce the photosynthate for storage in the roots.

Cocoyam is often cultivated as an associated crop with maize, cassava and yams or even cocoa. It is mainly a wet season vegetable, but varieties that grow in marshy areas are available year round. Where large quantities are found it is quite an important commercial vegetable.

Apart from the cocoyam leaves, the study areas also produce *Corchorus* spp., *Amaranthus* spp and *Hibiscus sabdariffa*, all in relatively limited quantities. These are considered as vegetables of the people of the northern parts of the country. They are therefore not an important part of the food culture of the people of the area studied. They are cultivated for their commercial value.

Post harvest Arrangements and Preservation Techniques: Cocoyam leaves are usually harvested early in the morning or late in the evening and tied into bundles before sale to the middle women who may travel all the way to the village or meet the farmers at vantage points in or outside the city.

In the case of *Corchorus* spp., *Amaranthus* spp. and *Hibiscus* spp, the farmer does only a few initial harvests. The itinerant market queen, who also determined the value of the produce, then did all the other subsequent harvests.

The constraints and problems associated with the production of the TLVs in both the dry-savannah and forest ecozones are summarized in the problem tree Fig. 8 (Annex 10).

2.4.2 Output 2

Product Inventory: At the Tamale markets, it was established that, in general, about eighteen (18) different types of vegetables (both traditional and exotic) are sold. However, most of these vegetables are scarce during the dry season. Table 4 presents the percentages of TLVs vegetables traded, relative to the exotic vegetables. The common indigenous leafy vegetables include *Hibiscus sabdariffa* (Bra), *Corchorus* spp. (Ayoyo) and *Amaranthus spp* (Alefu). The popular exotic leafy vegetables include cabbage and lettuce. Other vegetables including okra, cowpea leaves and sesame leaves were also on sale but in smaller quantities.

Packaging and Market Presentations: At the farm gates, TLVs are tied in bundles and packaged in baskets for sale. For easy transportation to market centers, the itinerant traders package in jute and polypropylene sacks. Good presentation is considered important since fresh well-presented produce always attract customers. Fresh TLVs are sorted, cleaned and washed and displayed openly on tables or bowls for sale (Plates 3 and 4, Annex 11). They are regularly sprinkled with water to maintain freshness and turgidity. Retailers and wholesalers travel to vegetable producing communities to obtain supplies. Some farmers also carry their vegetables to the markets in Tamale for sale to both consumers and retailers, usually during the market days. No evidence of contractual arrangements between the traders and vegetable producers was revealed. Generally, retailers buy vegetables in small bundles while wholesalers buy in large quantities in polypropylene sacks. A bag may take three to five days to sell. Retailers bought vegetables in the afternoon and evening from farmers and wholesalers who travel to the market.

Consumer Preferences: Consumers prefer fresh and large green vegetable leaves regardless of whether the leaves had holes or not. Cleanliness is another important quality required by customers for both indigenous and exotic vegetables. The survey shows that consumers patronize more exotic vegetables than indigenous vegetables. Among the TLVs, *Corchorus* spp. is the most preferred (Table 4).

Table 4

Consumer preferences for leafy vegetables sold at the Tamale Market

Vegetables	Score	Rank
Garden egg	15	12
Cassava leaves	22	8
Adansonis digitata (baobab)	32	5
Onion	18	10
Sweet pepper	20	9
Cabbage	28	6
Okro leaves	24	7
Amaranthus spp ('alefu')	68	2
Hibiscus sabdariffa ('bra')	44	3
Corchorus spp ('ayoyo')	77	1
Cucurbita spp. (Pumpkin)	16	11
Cowpea leaves	39	4

Short-term storage: Vegetable traders reported that indigenous vegetables could be stored for 2-3 days while exotics could be stored for 5-7 days. There was no special packaging used in the handling of vegetables in the markets surveyed. Leafy vegetables such as *Amaranthus* spp. ('alefu') and roselle, *Hibiscus sabdariffa* ('bra') are first tied into bundles. The bundles are then tied into bales using strings.

There were no storage facilities for vegetables. The only preservation techniques used by traders for unsold vegetables was to pack them in baskets, sprinkle water on the leaves and cover them with moistened sacks/clothes and kept in the shade to reduce transpiration. Unsold roselle and cowpea leaves are sometimes left standing in water.

Seasonality: Almost all the vegetables are available for sale in the markets both in the wet and dry seasons as a result of increasing interest in dry season gardening in peri-urban communities with mushy lowlands and dam sites. Usually the market for TLVs slows down during the rainy seasons because most households grow them.

Prices: Table 5 (Annex 12) shows the prices for the TLVs, alongside those for exotic vegetables, sold at the Tamale markets. Prices for the vegetables tend to be low in the wet season because it is the main production period, and for that matter many households get vegetables either from their own farms or from friends and therefore need not buy them from the market. For the traditional leafy vegetables price decrease/increase is mainly reflected by change in the volume rather than in the amount of money (value) of the commodity. For example, about trice the quantity per unit value sold in the dry season will be sold for the same price in the wet season. On the other hand, abundance or scarcity of exotic vegetables from the market is reflected in change in both volume and value. During the dry season half the quantity of a given exotic vegetable can sell as high trice it price in the wet season.

In the Forest ecozone where the main TLV is the cocoyam leaves, the prices (in Table 6, Annex 12) are to a large extent influenced by the bimodal nature of the rainfall pattern in study area.

Incomes: For most of respondents at the Tamale markets, vegetables are the only commodities they sell in the markets. These vegetables therefore constitute the main source of income for the traders. Even though traders tended to be very reluctant to divulge information about their income, it was very apparent that traders are able to make a profit out of trading in vegetables. As shown on Table 7 (Annex 13), okra, cabbage and garden eggs provided the most income to the traders. Among the leafy vegetables, leaves of cowpea and *Amaranthus* spp. are ranked as the most important source of income.

Socio-cultural considerations: The survey revealed that socio-cultural significance of TLVs was an important factor affecting demand for TLVs in any particular community. It was clearly evident from the survey that the type and consumption patterns, evolved over the years in any one community, for the TLVs, depended on the different ethnic

groups present in the particular community. Marketing of cocoyam leaves at the Tamale markets was virtually non-existent. On the other hand marketing of *Hibiscus sabdariffa* ('bra'), *Corchorus* spp. ('ayoyo') and *Amaranthus spp* ('alefu') was hghly limited in most parts of forest zone.

At the Kumasi Central Market, these three TLVs, as well as others from the dry-savannah ecozones, are sold; albeit highly restricted to only a few traders. Those who patronize these dry-savannah TLVs are the large settler of northerners in the Kumasi Metropolitan area. Most indigenous Akans do not buy these TLVs. They have an unfortunate social stigma against these TLVs. Not surprising, these TLVs are completely absent at most rural markets in the forest ecozone. When questioned about the bias against the trading of the TLVs, most of traders at the Kumasi Central said they considered as "weeds" in the Akan communities. However, some respondents indicated that *Corchorus* spp and *Amaranthus* spp. are gaining recognition among the Akans partly, due to the current economic hardship. It was also realised that because of the immigrant Northerners in the Ashanti region, some of the Akans now enjoy some Northern dishes prepared with TLVs other than the popular cocoyam leaves especially, *Tuo zaafi*. Surprisingly, consumption of cocoyam (*Xanthosoma mafaffa*) leaves was not popular among the Northerners.

Other TLVs had cultural identity in the consumption patterns of the Northerners in the Ashanti region. They were used in the preparation of foods served at traditional ceremonies like funerals, child naming and marriages. TLVs were also believed to have special medicinal and nutritive qualities. For example, the leaf of *Vernonia amygdallina* (locally referred as *soaka* or bitter leaf) is was used for the treatment of diabetes and low blood pressure. It was for the preparation of special diet for pregnant and lactating mothers.

Distribution channels for TLVs: At the Tamale market, the distribution of TLVs is fairly simplified because most of the women farmers carry the freshly harvested TLVs direct to the markets for sale. It was found that distribution of TLVs was relatively simply due to their perishable nature and lack of storage techniques as well their narrow utilisation base in the study area. The majority of agricultural produce is sold through local periodic markets usually organized on a 6-day cycle. In the selected zone, Tamale is the major urban market and functions as a relay market for the area, attracting traders from within the region. In the farm household, the woman has the responsibility of marketing the TLVs from the farm. Many petty traders who are mostly producer-sellers therefore characterize the rural markets. They sell the surplus directly to consumers through the local markets and also to local market traders or women who buy from others in the same village or nearby villages.

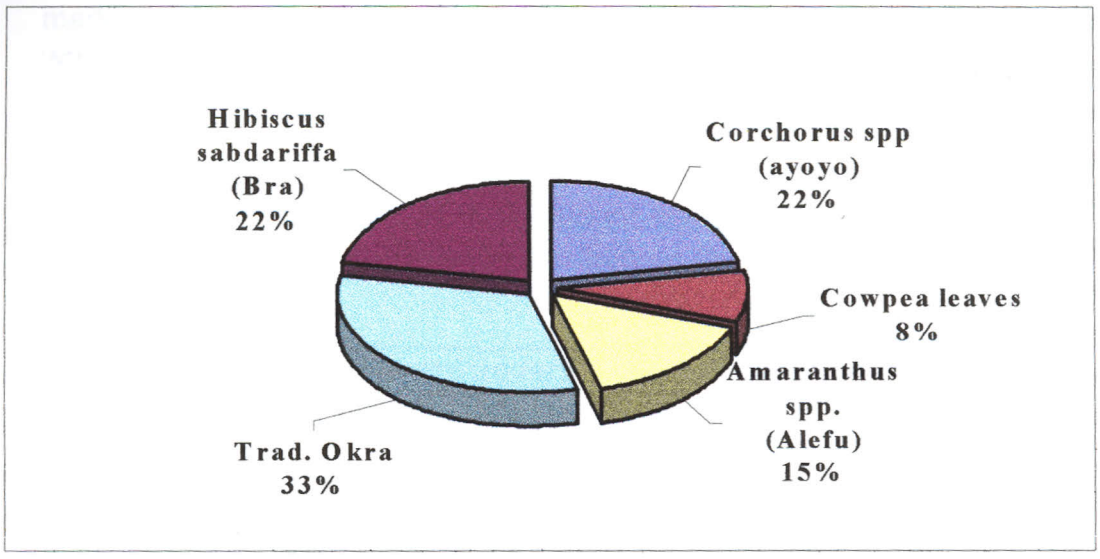


Fig. 9 Popular TLVs sold at the Tamale Markets in Ghana

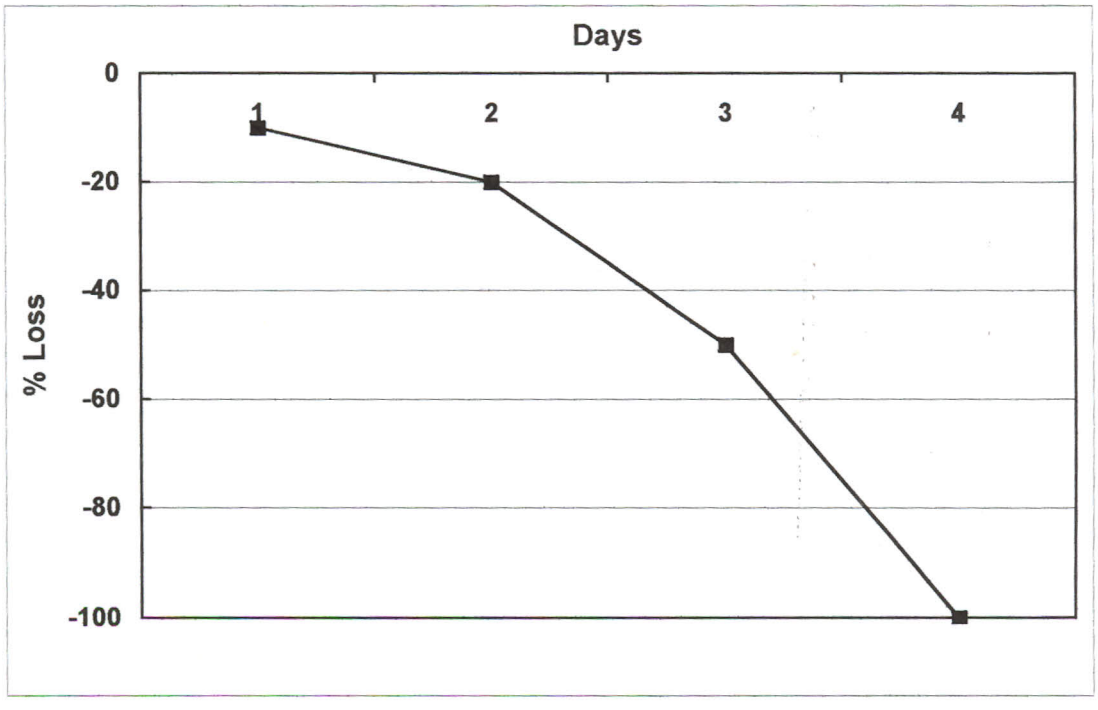


Fig. 10 Percentage losses during the storage and sale of the leaves of *Xanthosoma mafaffa* ('Nkontomre')

In the Forest ecozone, the main distribution channels identified were;

i. Direct sales by producer-sellers to consumers. This involves the farmer marketing his/her own product, generally in small quantities, to consumers. It was commonly used at the primary market level for distributing cocoyam leaves.

ii. From producer to resident trader to consumer /institution/itinerant traders. Here the farmers sold in large quantities to resident traders who usually retailed along roadside to commuters. These resident traders also sold cocoyam leaves in large quantities to educational institution or to other itinerant traders who visit the rural markets.

iii. Farmers ⟶ itinerant traders ⟶ retailers ⟶ consumers.

The itinerant traders assembled fresh TLVs at the farm-gate and distributed in large quantities to retailers on the markets. This was a popular channel for other TLVs. Drying of TLVs for sale in the lean period was mostly done at the retail level to ensure regular supplies to customers.

2.4.3 Output 3

2.4.3.1 Effect of use of packaging, reduced temperature and high humidity on the shelf-life of the *Amarnthus viridis, Corchorus olitorius and Hibiscus sabdariffa* .

Fig. 11 shows that comparatively the discoloration of the leaves of *Corchorus* spp. occurred at a significantly lower rate than in the other two leafy vegetables, *Amaranthus* spp and *Hibiscus* sabdariffa. These results appear to correlate well with those obtained in Fig. 12 because decay is as a result of the death of certain parts of the leaves. The trends in Fig. 13 relate to the breakdown in the internal tissues. Normally, breakdown of the internal tissue is one of the internal changes accompanying senescence processes (Johnson & Hodari-Okae, 1999, Shewfelt, 1993 and Willis *et al.*, 1981), hence, the very good correlation between Fig. 11 and Fig.13. Table 8 shows that the bacteria counts correlated better with the decrease in hand-feel (Fig. 13) in Amaranthus viridis than the rest of the TLVs. The shelf-life (represented by Fig. 14) increased in the order of *Hibiscus sabdariffa* (by 3 days) < *Amaranthus viridis* (by 6 days) < *Corchorus olitorius* (by 10 days). *Corchorus olitorius* obtained the best rating for overall quality impression.

Fig. 11 Effect of use of perforated polyethylene on the leaf discolouration of three TLVs during storage at 6±1 °C and 83 ± 2 % RH

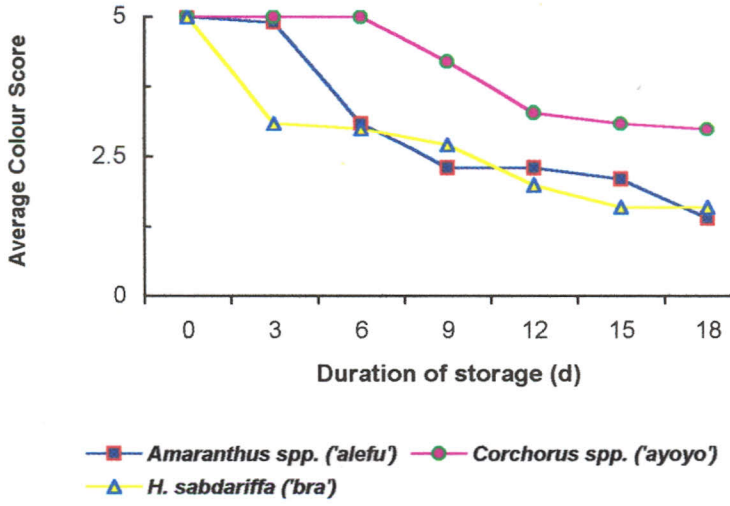


Fig. 12 Effect of use of perforated polyethylene on the visible decay in three TLVs during storage at 6 ± 1°C and 83±2 % RH

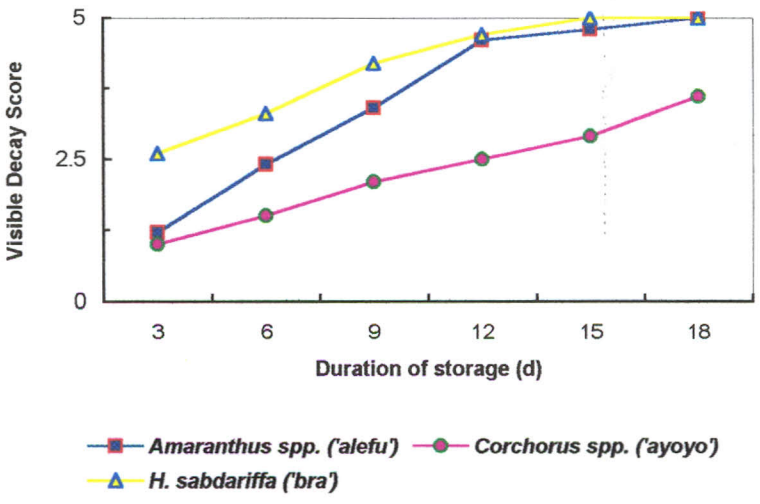


Fig. 13 Effect of use of perforated polyethylene on the hand-feel during storage of three TLVs at 6 ± 1 °C and 83 ± 2 % RH.

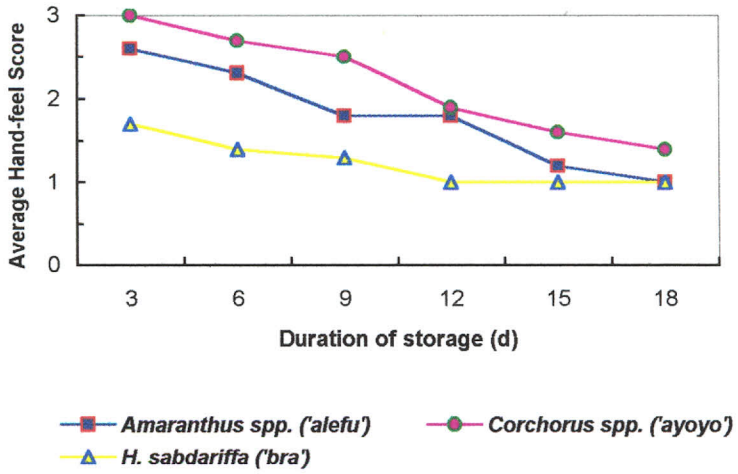
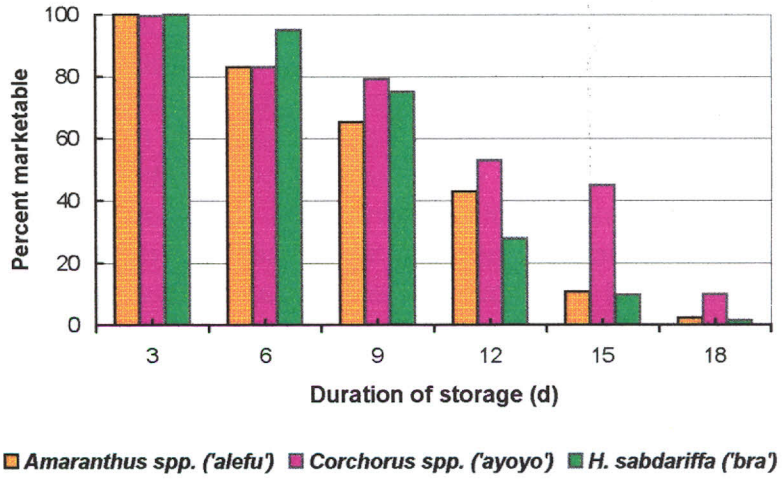


Fig. 14 Effect of use of perforated polyethylene on the percent marketability of three TLVs during storage at 6± 1 °C and 83 ±2 % RH



2.4.3.2 Effect of traditional parboiling on the micronutrient contents of the TLVs

Table 6

Nutrient retention after traditional parboiling for 30 min using 10 parts of water

TLV	% Retention of micronutrients (mg /g dry weight basis)			
	Vitamin A	Vitamin C	Iron	Zinc
Amaranthus spp	89	75	80	85
Corchorus spp.	85	60	80	60
H. sabdariffa	79	78	85	n.a

2.4.3.3 Effect of the use of solar dehydration as a preservation technique for *Amaranthus viridis*, *Corchorus olitorius* and *Hibiscus sabdariffa*,

Fig. 15 gives the scheme used for the drying trials. As shown in Table 7, drying for all three TLVs occurred at a much faster rate in the solar dryer than under the shade. This must have influenced the amount of residual microbial load at the end of the drying (Table 8). However, Table 9 indicates that unfortunately the use of the solar dryer affected vitamin A and C contents of the leaves. The high temperatures destroys these nutrients through oxidation and too much heat cause protein to 'brown' thus reducing the protein quality (Gomez, 1981). Gomez (1981), working on the drying of mango and papaya, has also commented that carotene retention in ambient temperature-dried fruits was lower than in solar-dried fruit; with continued losses in storage. Compared to the drying in the shade, drying in the solar dryer affected the colour of the leaves (Fig. 16). This is reduction in green is attributed to the destruction of the chlorophyll (Negi & Roy 2000). From these, it looks like the best way to dry these TLVs would be in the shade, using the warm air to evaporate moisture out of the TLVs as quickly as possible.

Fig. 15 SCHEME FOR SOLAR DEHYDRATION OF THE TLVS

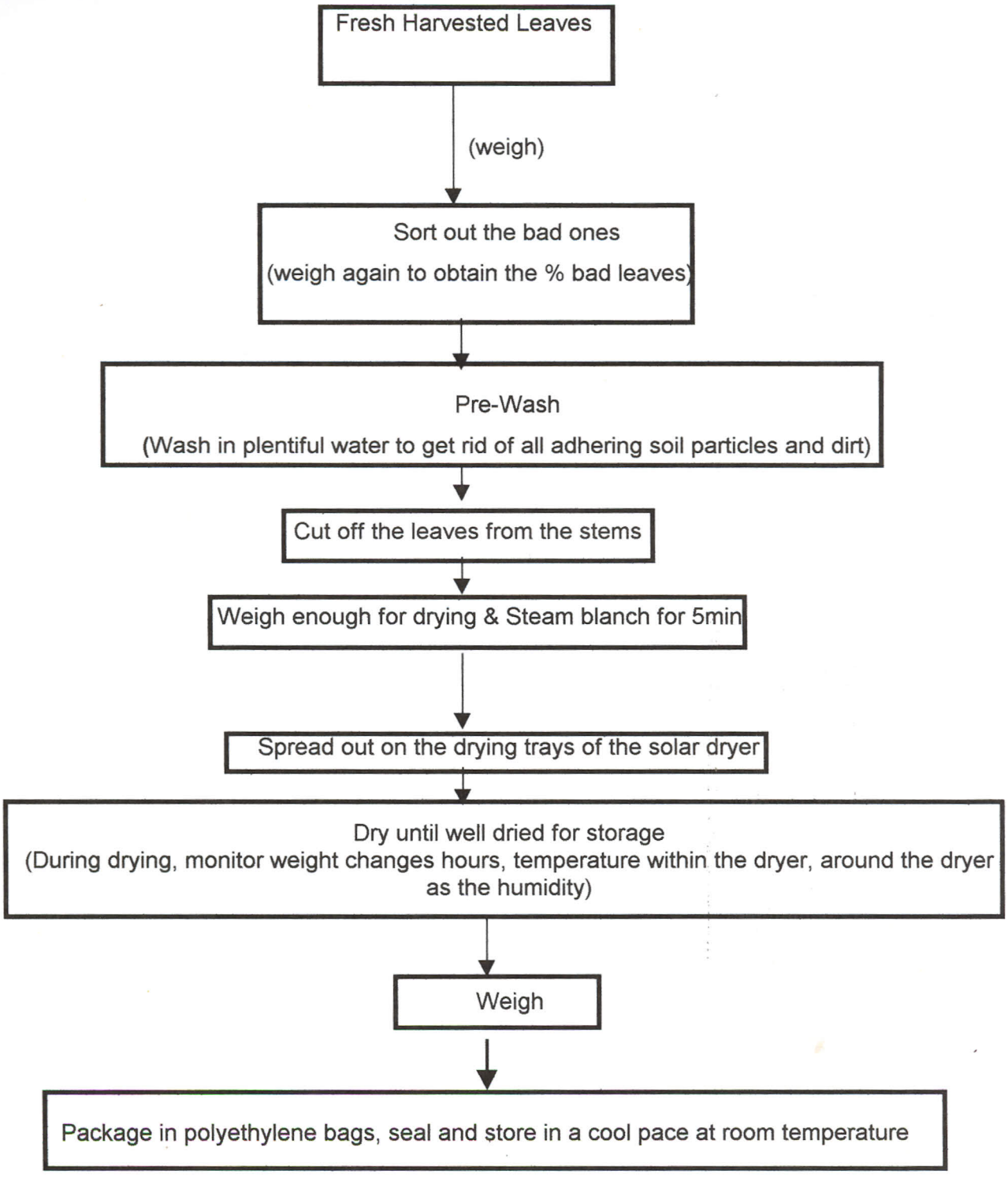


Table 7

Summary of drying experiments carried out on the three TLVs

TLV	Amount of Material (kg)		Drying Time (h)	Average drying temperature (°C)	Initial moisture content (%)	Final moisture content (%)
	Initial	Final				
Amaranthus spp (solar drying)	2	0.42	7	50	89.5	4.3
Amaranthus spp (shade drying)	2	0.42	14	37	89.5	6.2
Corchorus spp (solar drying)	2	0.35	6	50	85.6	5.5
Corchorus spp (shade drying)	2	0.36	16	37	85.6	6.5
Hibiscus sabdariffa (solar drying)	2	0.23	6	50	84.5	4.5
***Hibiscus sabdariffa* (shade) drying)**	2	0.26	15	37	84.5	6.7

Table 8

Microbiological status of the TLVs immediately after solar- or shade-drying

	Amaranthus spp		*Corchorus spp.*		*H. sabdariffa*	
	Solar-dried	Shade-dried	Solar-dried	Shade-dried	Solar-dried	Shade-dried
Total Bacterial Count/g	4.8×10^3	5.6×10^6	4.5×10^3	5.9×10^8	1.32×10^3	1.14×10^6
Mould and Yeast Count/g	< 10	5×10^1	< 10	1.3×10^1	< 10	4×10^1
Coliforms (0.1 g)	Not found	Not found	Not found	Not found	Not found	Not found

The two tables (Tables 7 & 8) above indicate that the solar-drying treatment helps to achieve a more stable preserved product in a much shorter time than the shade-drying treatment.

Table 9

Nutrient retention percentages in solar and shade-dried TLVs

Nutrient	*Amaranthus spp*		*Corchorus spp.*		*H. sabdariffa*	
	Solar-dried	Shade-dried	Solar-dried	Shade-dried	Solar-dried	Shade-dried
Vitamin A	89	90	85	89	79	80
Vitamin C	75	75	60	62	78	78
Iron	83	85	82	83	85	88
Zinc	82	85	72	73	n.a	n.a

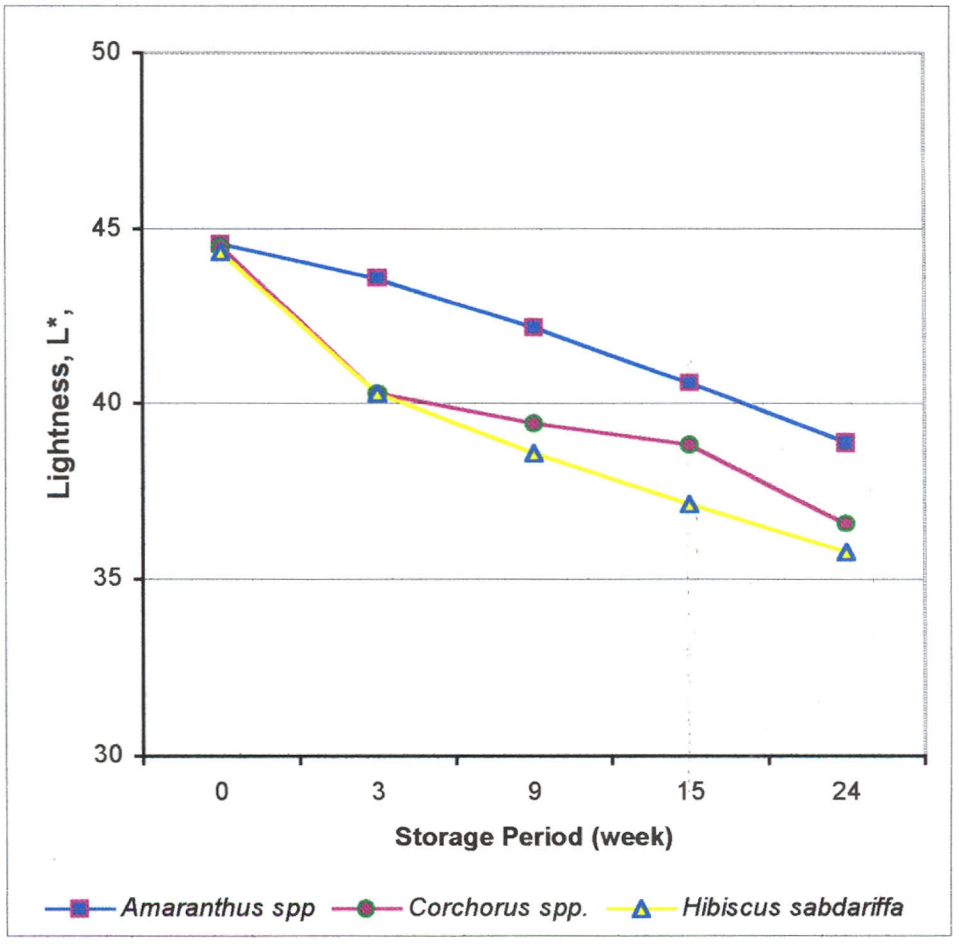


Fig. 16 Trends in Lightness. L*, parameter of solar-dried TLVs during storage in polyethylene pouches at room conditions (30 ± 2 ° C and 78± 2 % RH)

2.4.4 Output 4

Overall, nearly 80 % of the respondents (n=100, in each city) claimed not to be using any dry-savannah TLVs regularly. Only 10 of the remaining said they used the TLVs occasionally. This is in shape contrast with the popular use of the leaves of *Xanthosoma maffafa* (locally referred to as Nkontomire), which is the main TLV from the forest zone. According to respondents who use the TLVs from the dry-savannah regularly, they believe were rich in nutrients espcially in vitamins. Their order of preference was *Amaranthus* spp> *Corchorus* spp > *Hibiscus sabdariffa*.

Amaranthus is most liked because it is used in the preparation of both stews and soups, and has very nice aroma and texture. *Corchorus* spp was also liked because of its strong aroma and slippery nature, but has a good taste and soft texture. *H. sabdariffa* is liked for its sour taste and slightly rough texture. These sensory properties according the respondents are very good for soups.

All respondents preferred the fresh leaves to dry or processed ones. Their main reasons being that they were of better nutritional qualities, aroma and taste.
The survey also differences in the preparation methods for the three TLVs, when compared to those found during the PRA in the dry savannah ecozones. These differences were in respect of cooking time, spicing and cooking methods. The TLVs are cooked for shorter period. In soups, the chopped leaves were the last ingredient added to the cooked soup and usually after allowed to simmer for 10-15 min.
The use of *Amaranthus* spp for the preparation of popular 'palaver sauce' stew was a major difference and innovation in cooking methods identified in this study.

The basic /traditional 'palaver sauce' stew is prepared with melon seeds ('agushi'), tomatoes, onion and pepper and chopped leaves of *Xanthosoma mafaffa* ('Kontomire') added to the stew base. The stew is then allowed to simmer for about 5 min. It is important to note that although there were differences in the preparation of the TLVs, all respondents had a good knowledge of the traditional preparation methods.

Nearly 82 % of the respondents who constantly use the three TLVs said they obtained their supplies of the TLVs from the main markets in Accra and Kumasi (50%). 12 and 6 % obtained from backyard gardens and vegetable growers, respectively.

Generally, prices of TLVs are higher in Kumasi than in Accra. This may be attributed to an expanded market or higher demand for TLVs in Kumasi that in Accra.

3.0 Constraints and Solutions

The TLVs from the dry-savannah ecozone, like *Amaranthus* spp., appear to have a lot of problems compared to those from the forest areas. The discussion below therefore concentrates on the TLVs from the dry-savannah areas.

The constraints affecting the use of TLVs run through production, post-harvest management, marketing and utilisation. In production the biggest worry of almost all the farmers is with the nature and adequacy of planting seeds. Seeds are usually collected from market queens to whom they are obliged to sell their produce. In most cases, the seeds were a mixture with different growth characteristics. Though some farmers store their own seeds, but they do this from their plants that are often not uniform in attributes. There is therefore the urgent need for research into improving the situation with the planting seeds. Research must be geared towards characterising of the local and exotic germplasm and the development of improved varieties. In particular research must focus on selecting and breeding varieties of shorter duration with better water and nutrient use efficiency.

Another major worry is insect pest infestation during production. This usually reduces the quantity as well as the market value of the TLVs. Farmers complained bitterly about the prices of pesticides that could help control this problem. Thus it would advisable for integrated pest management programs introduced to the farmers.

Water for planting is also a major problem. With the exception of areas with dam or irrigation facilities, the perennial droughts in most parts of the dry savannah areas greatly affect production. This situation contributes to low yield and does not encourage expansion of land area. At such sites, farmers suggested that they could increase their farm sizes if they were assisted to build dug out or local well that will provide them with sufficient water through the dry season. There is the need to research into water harvesting and conservation techniques at these sites.

High cost of inorganic fertiliser and scarcity of poultry manure were mentioned as the constraints in the production of leafy vegetables. Soil fertility maintenance was a great issue to the gardeners interviewed. Almost all of them were ignorant about compost and liquid manure preparation.

Post-harvest management of TLVs is another big worry. Most farmers and traders do have not adequate knowledge about or techniques on how to increase the keeping qualities the TLVs. This greatly affects the marketing of the TLVs. The studies also revealed that not much research and development on methods of preserving and/or improving keeping qualities of these TLVs have been carried out.

This same problem was found with the utilisation. Studies into the role that the TLVs found in Ghana can play in alleviating the high levels of micronutrient deficiencies found in several parts of the Ghana, especially in the dry-savannah areas and among the rural poor are virtually non-existent. It was difficult to find work carried out determining the

micronutrient contents, effects of preserving and/or processing techniques on the micronutrients from secondary data. As yet no formal recipes using these TLVs have been developed and/or documented.

Undesirable sensory characteristics especially the bitterness promotes prolong pre-cooking of the TLVs which results in considerable loss of the micronutrients either by destruction or through leaching. An additional problem of the undesirable sensory characteristics is the resulting reduced consumption.

The TLVs from the dry savannah areas are unpopular in densely populated southern parts of Ghana, because of a number of reasons. Key among them is poor packaging and presentation, lack of knowledge about the use and preparations of foods using these TLVs and unfortunately, negative socio-cultural perceptions about these TLVs. To improve their acceptance there is the need to mount an intensive popularisation and awareness creation campaign.

4.0 Conclusions and Recommendations

This project sought to gather baseline information on the production, marketing and use of traditional leafy vegetables in Ghana. The general aim was to investigate whether these vegetables could assist in improving the micronutrient contents of the diets of Ghanaian families. This study has revealed that there are a lot of traditional leafy vegetables that can potentially be developed and introduced into the mainstream foods of Ghanaians to help improve the overall micronutrient status of the inhabitants. Unfortunately, a number of problems currently dogged the effective utilisation of these vegetables. This preliminary study has identified most of them and concept note is being developed for a major research and development project to solve the problem.

5.0 References

Abbiw, D. K. (1990) Useful plants of Ghana. Intermediate Technology Publications and the Royal Botanic Gardens, Kew.

Barth, M.M., Perry, A. K., Schmidt, S. J. & Klein, B. P. (1992) Misting affects market quality and enzyme activity of broccoli during retail storage. *J. Food Sci.*, **57**, 954.

Brett, A. Cox, D.R. S. Trim, D. S. Simmons, R. & Anstee, G. (1996) Producing solar dried fruit and vegatbles for micro-and small-scale rural enterprises developemt: Handbook 2 to 4. Chatham, UK: Natural Resources Institute.

Chweya, J. A. & Eyzaguirre, P.B. (1999) *The biodiversity of traditional leafy vegetables*. Rome: International Plant Genetics Resources Institute.

Hardenburg, R. E., Watada, A. E. & Wang, C. Y. (1986) The commercial storage of fruits, vegetables and florist and Nursery stocks. USDA Agricultural Handbook No. 66 U.S Gov t Printing Office, Washington DC

Johnson, P-N. T. & Hodari-Okae, M.A. (1999) Influence of wood species on moist saw-dust storage of tomatoes.*Tropl Sci.*, **39**, 214 – 219.

Langerak, D. Is. (1978) The influence of irrdiation and packaging on the quality of prepacked vegetables. *Ann. Nutr.Alim.*,**2** ,569-586.

Lers, A. Jiang, W, Lomaniec & Aharoni, N. (1998) Gibberellic acid and CO2 additive effect in retarding postharvest senescence of parsley. *J. Food Sci.*, **63**, (1), 66 –68.

Meir, S. Philosph-Hadas, S. & Aharoni, N. (1992) Ethylene-increased accumulation of florescent lipid-peroxidation products detected during senescence of parsley by a newly developed method. *J. Amer Soc. Hort Sci.* 117: 128 – 132.

Nabasa, J., Rutwara, G., Walker, F. & Were, C. (1995) *Participatory Rural Appraisal: Principles and Practicalities*. Chatham, UK: Natural Resources Institute.

Negi, P.S & Roy, S.K. (2001) Effect of drying conditions on quality of green leaves during long term storage. *Food Research International*, 34, (4) 283 - 287.

Norman, J. C. (1992) Tropical Vegetable Crops. Devon: Arthur H. Stockwell.

Quarshie, K. & Agble, R. (1999) A study on anemia in Ghana. Paper presented at INACG Symposium. March 12, 1999 Durban, South Africa.

Shewfelt, R.I. (1993) Stress Physiology: A cellular approach to quality. In*: Postharvest Handling: A systems approach* (ed. R.L Shewfelt and S.E. Prussia). London: Academic Press Risse, L.A. & Miller, W.R. (1983) Film decay of eggplant, *Proc Fla. State Hortic Soc.*, **96**, 322-324.

Shewfelt, R.L.C. (1994) Quality characteristics of fruits and vegetables. In*: Minimal Processing of Foods and Process Optimisation: An Interface* (eds) R.P. Singh & F.A. R. Oliveira. London: C.R. C. Press.

Sherman, M. & Allen, J.J. (1983) Impact of post-harvset handling procedures on soft rot decay of bell peppers, *Proc Fla. State Hortic Soc,* **96**, 320 - 322.

Sherman, M. Kasmire, R.F. Schuler, K.D. & Botts, D.A. (1982) Effect of pre-cooling and peduncle lengths on soft rot decay of bell peppers. *Hortic Sci.*, **46**, 511- 516.

Willis, R.H.H, Lee, T.H.Graham, D. McGlasson, W.V. & Hall, E.G. (1981) Postharvest: an introduction to the physiology and handling of fruits and vegetables. London: Grenada.

Yano, T. Kojima, I. & Torikata, Y. (1981) Role of water in withering of leafy vegetables. In: *Water Activity: Influences on Food Quality* (ed. L. B. Rockland and G.F. Stewart), 765-780.. New York: Academic Press.

ANNEX 1

Checklist Used for Rapid Rural Appraisal (RRA)

Region, District, Town/village and Location/ Suburb
Local name for TLV; English/ Scientific Name
Take a picture of the TLV; if possible take a picture of the farm
Size of farm, production patterns etc
Who is/are involved in the production of the TLV
How many people in the town/village are involved in the production of the TLV?
Do the local people consider the production of the TLV as an income generating venture?
After harvesting of purchasing, how long (days) before TLV is used.?
Can the TLVs be preserved in any way /
Various uses: in food preparations and as medicine.
Brief description of how the dishes are prepared.
If cooked, for how long is the cooking done; estimate time used.
Which parts of the TLV are used for food or medicine.
How many days in a week are the TLV eaten in the household?
Rank how important are the various TLVs in the diets of the local people.

ANNEX 2 CHECKLIST USED FOR THE PRA

TOPIC 1: TRADITIONAL LEAFY VEGETABLES (TLVs) PRODUCTION

SUB TOPICS	APPLICABLE TOOLS AND TECHNIQUES				
	Source of information	***S. S.I***	*Diagrams & Others*	*Direct Observation*	***Secondary sources***
Farming & Cropping Systems for TLVs -Cropping patterns -Land preparation -Fertilizer application -Varieties/diversity -Constraints & coping strategies -Any germplasm issue (maintenance of seeds-field storage)	Farmers	*applicable*	Seasonal calendar	*applicable*	*Applicable (CRI,MoFA,NGOs etc)*
Relative importance -Acreage -Production-no of times -Site -Sales/consumption	Farmers	*applicable*	Pie chart Histogram Ranking	*applicable*	*Applicable (MoFA,NGOs Etc)*
Socio-economic Profile -Land ownership -Social infrastructure -Family size/distribution -Gender roles and decision making -Other income generating activities -Access and control of resources. -Is TVL irrigated?Source of water;cost -Association	Farmers	*applicable*	*applicable*	*applicable*	*applicable*
Additional issues on the production of TLVs +description of the TLVs +					

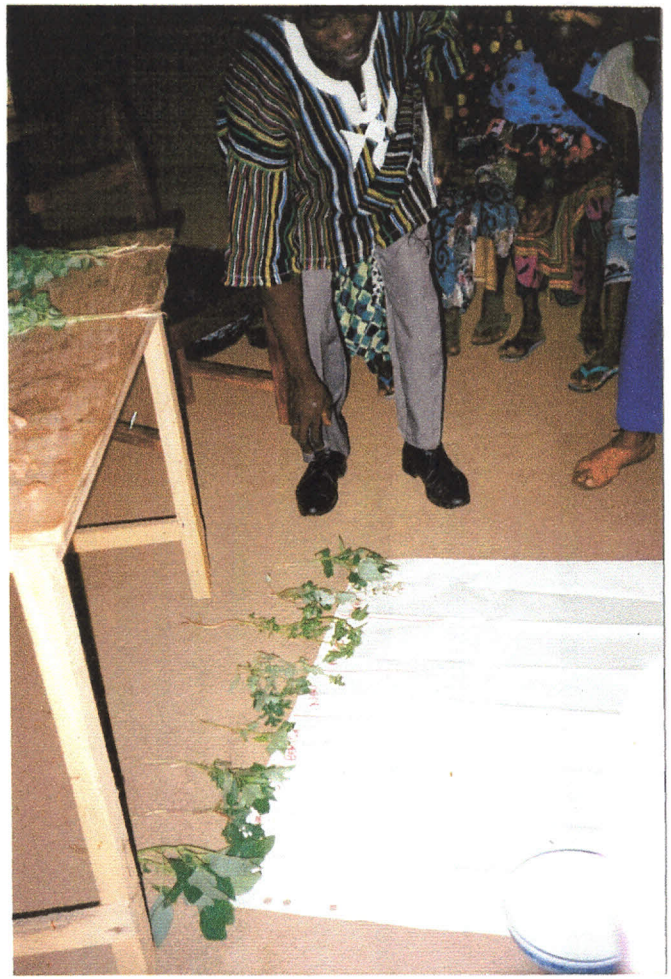
TOPIC 2: MARKETING & PRESERVATION OF TLVs

SUBTOPICS		APPLICABLE TOOLSAND TECHNIQUES			
	Source of information	*S.S.I.*	*Diagrams and Others*	*Direct Observation*	*Secondary Sources*
Marketing of TLVs Functions:-Transport -Financing -Preservation of TLVs-packaged? Exposed or covered? Channels:-Structure/organization Seasonal availability and price variation -Access to market -Channels of distribution **Cost and profit margins?** -Variable and fixed cost	Farmers and traders	***Applicable***	*Pictures*	*applicable*	*Applicable Traders and vegetable associations*
Preservation of TLVs -Shelf life of TLVs -Techniques of maintaining the freshness of TLVs -Dehydration/drying methods -Other processing methods -Storage and quality issues of preserved forms of TLVs during season and off season	Farmers and Traders	*Applicable*	Pie chart Histogram,,pictures	*applicable*	*applicable*
Additional issues of the marketing & preservation of TLVs +gender roles,+seasonaility +Plant/machinery/equipment used etc. +consumer preference (basis),ranked	Farmers and traders	*applicable*		*applicable*	

TOPIC 3

SUBTOPICS	**APPLICABLE TOOLS AND TECHNIQUES**			
	Source of information	S. S. I.	***Diagrams & others***	***Secondary Sources***
Background and utilisation methods. -List of TLV used as food Preferred species and their rankings -Methods of use-- in soups, stews condiments. -Perceptions about TLVs used as foods -Any traditional knowledge about the TLVs	Farmers traders and households	***applicable***	Histograms, pie charts'pictures etc.	***Applicable*** (CRI,UDS,MoFA,NGOs etc)
Descriptions of utilisation methods. -Preparation of the leaves for cooking Cooking time/duration -Parts of the TLVs used -Average number of times used/week -As aside dish or main dish?				
Use of TLVs as food -Proportion of TLVs as main meal ingredient -Average number of people in the house -Are the TLVs harvested directly or are they purchased?				
Socio-cultural considerations -TLVs used for medicine -TLVs used for ceremonial events. -Perceptions about unused TLVs -Any religious belief against any TLVs.	Farmers traders and households			

INEX 3



Plates 1 & 2: **Farmers quantifying their production levels and preferences**

Annex 4 : Checklist Used for the Marketing Survey

Market description: Count the number of sellers of vegetables differentiating between those who sell TLvs only, exotic only or both Exact as much as you can from the market-queen of the vegetables.

Traders details: Market actor (itinerant trader, retailer, wholesaler etc) gender, age source etc.

Product Inventory: What vegetable crops are being sold, source etc.

Trader perceptions of consumer preferences: Like and dislikes noted,

History of marketing: Experience –how long has s/he been selling TLVs etc.

Marketing arrangements: what are the marketing arrangements between you and the suppliers (ie farmers, itinerant trader, wholesaler etc) where do you meet, How often, time and location. Do you have contracts with your suppliers? How much do you buy ? How long does it take to sell? Which other markets do you sell I? Why don't you sell in other markets? Ae pices different in other markets etc.

Post-Harvest Techniques and Arrangements: What do you do to improve the keeping qualities, Do you have storage places etc.

Seasonality and Prices: At what times of the year are the vegetables most/least available? What are the price trends? How does the supply change with season etc.

Income: Is this your main source of income? Ranking/scoring . Rank commodities on sale in terms of importance as a source of income.

Constraints and Solutions: ranking/scoring. What are your main problems in the marketing of the TLVs and how do you think they can be solved.

Future plans: Would you like to expand your business? Yes/no/ and why in each case.

Annex 5: Assessing the extent of use and perceptions city dwellers in Ghana hold about *Amaranthus* spp., *Corchorus olitorius* and *Hibsicus sabdariffa*

1. Please state your profession and position (rank).
2. Which of these traditional leafy vegetables TLVs), from the north/dry savannah areas of Ghana, are you familiar with. Please tick.
   (a) Amaranthus ["Alefu"] (b) Corchorus spp [Ayoyo] (c) Hibiscus sabdariffa "Bra"
3. Have you ever heard about any them? Indicate which of them.
4. Can you identify any of these TLVs in the market?
5. If you have been using any of these, please rank in order of decreasing preference (most preferred first), the TLVs used, stating your reasons for the order.
   Use Table 1.

Table 1

Name of TLV	Rank	Reasons

6. What do you usually use these TLVs to prepare? Please tick.
   (a) Soups (b) Stews (c) both (d) Others (please state) .....

7. Briefly describe how these dishes are prepared. Indicate any major differences between the traditional method of preparation and what you do, where applicable.

.....

.....

.....

.....

8. In what form do you prefer to use the leafy vegetables. Please tick, stating briefly your reasons for the choice.

(a) fresh (b) dry (c) processed

6b If you prefer the fresh one to the dry, please briefly explain

.....

.....

6c If, on the other hand, you prefer the dried and milled type to the fresh, please briefly explain.

.....

.....

9. What is/are the source(s) of the leafy vegetables you use? Please tick.

(a) Your own backyard garden

(b) Market (please indicate which market).....

(c) Vegetable growers on small gardens in Accra.

10. In which months of the year are the leafy vegetables

(a) Abundant?.....

(b) Scarce?.....

11. (i) What are the current prices of a bundle of each of the following leafy vegetables in the

(a) Harvest season: Bra……

Alefu……

Ayoyo……

(b) Lean season: Bra……

Alefu……

Ayoyo……

(ii) What are the current prices of these leafy vegetables?

12. Please state your perceptions about the traditional leafy vegetables on the following (Table 2).

Table 2

	Alefu"	**"Ayoyo"**	**"Bra"**
Cooking properties			
Nutritional value			
Sensorial qualities (e.g. taste, aroma, texture, slipperiness, etc)			

11. Any extra comments or information you would like to share with us?

Annex 6

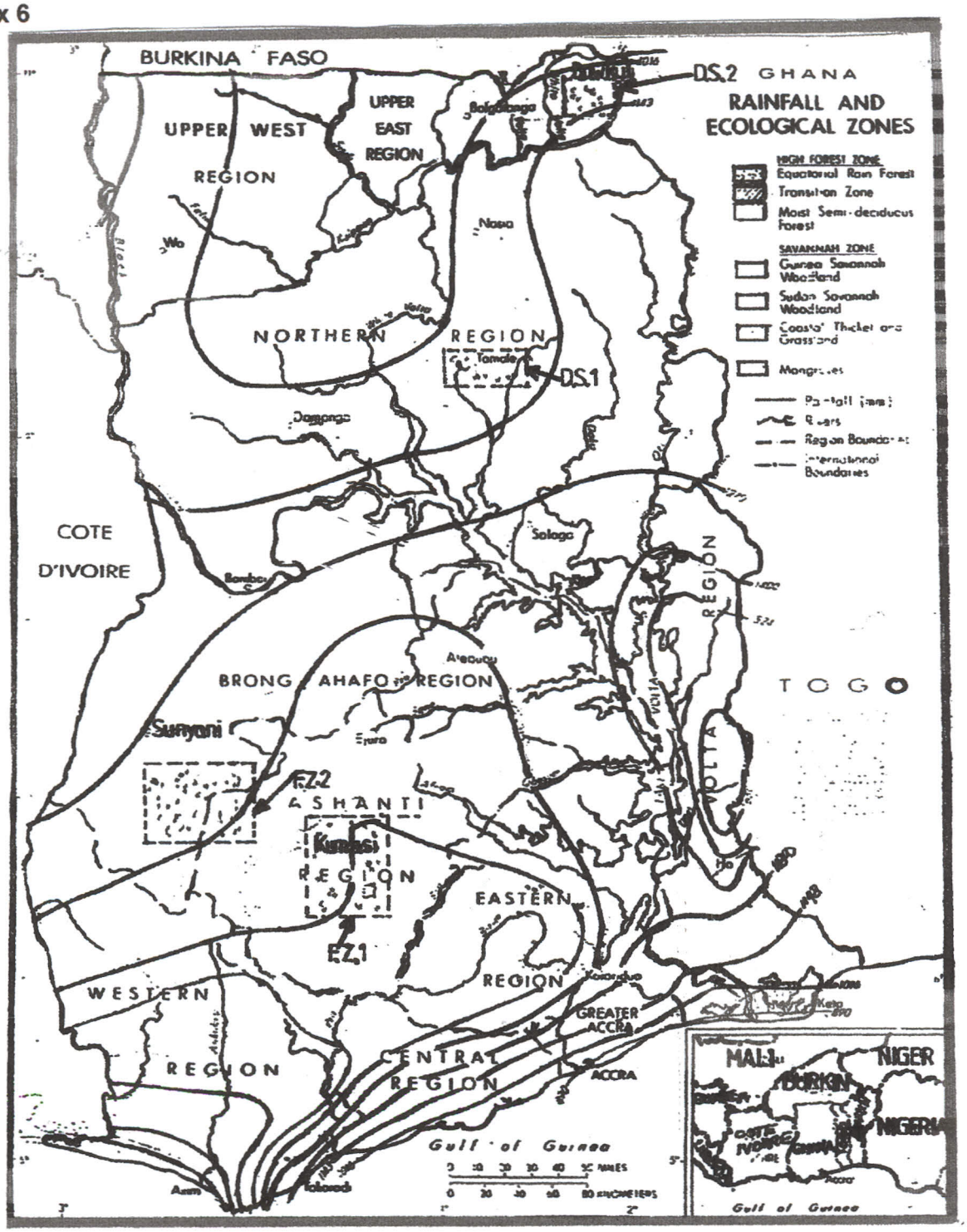


FIG. 1 MAP OF GHANA SHOWING THE STUDY AREAS

[DS1 and DS2 = Study areas in the dry- savanna ecozone
FZ1 and FZ2 = Study areas in the forest ecozone]

ANNEX 7

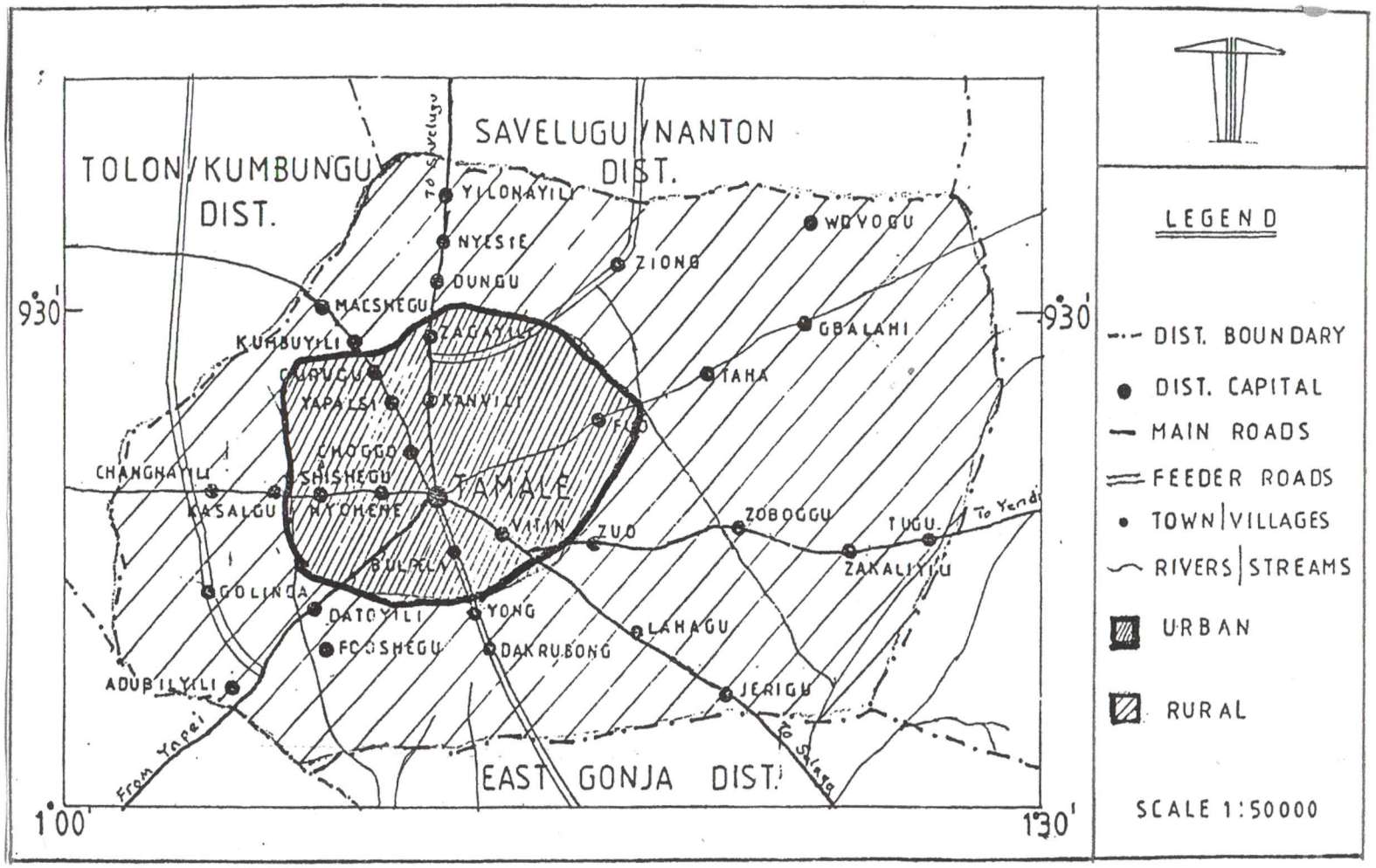


FIG. 2 TAMALE DISTRICT (NORTHERN GHANA) SHOWING THE DETAILS OF STUDY AREA DS1

ANNEX 8

Table 1

***Towns selected in the dry-savannah ecozone, their sources of water for crop production and production characteristics for* Amaranthus *spp.*, Corchorus *spp. and* Hibiscus sabdariffa.**

Selected Town	Source of water for crop production	% Total land area allotted to TLV cultivation			Main production problems (in ranking order)
		Amaranthus spp	*Corchorus spp*	*Hibiscus sabdariffa*	
[1]Gbulahagu	Dam, Irrigation Development Authority of Ghana	48	45	35	Lack of seeds/low yielding seeds; germplasm, soil fertility, drought
[1]Gurugu	Residual moisture in the soil	42	45	50	Insects pest, animal damage
[1]Zagyuri	Waste water/stream	60	56	56	Lack of help from Government agencies, lack of capital, low prices
[2]Binduri	Stream	50	50	60	Low market prices, lack of preservation and storage technologies
[2] Zuri	Stream/Local dam	55	65	60	Theft

[1]Towns in the Northern Region of Ghana

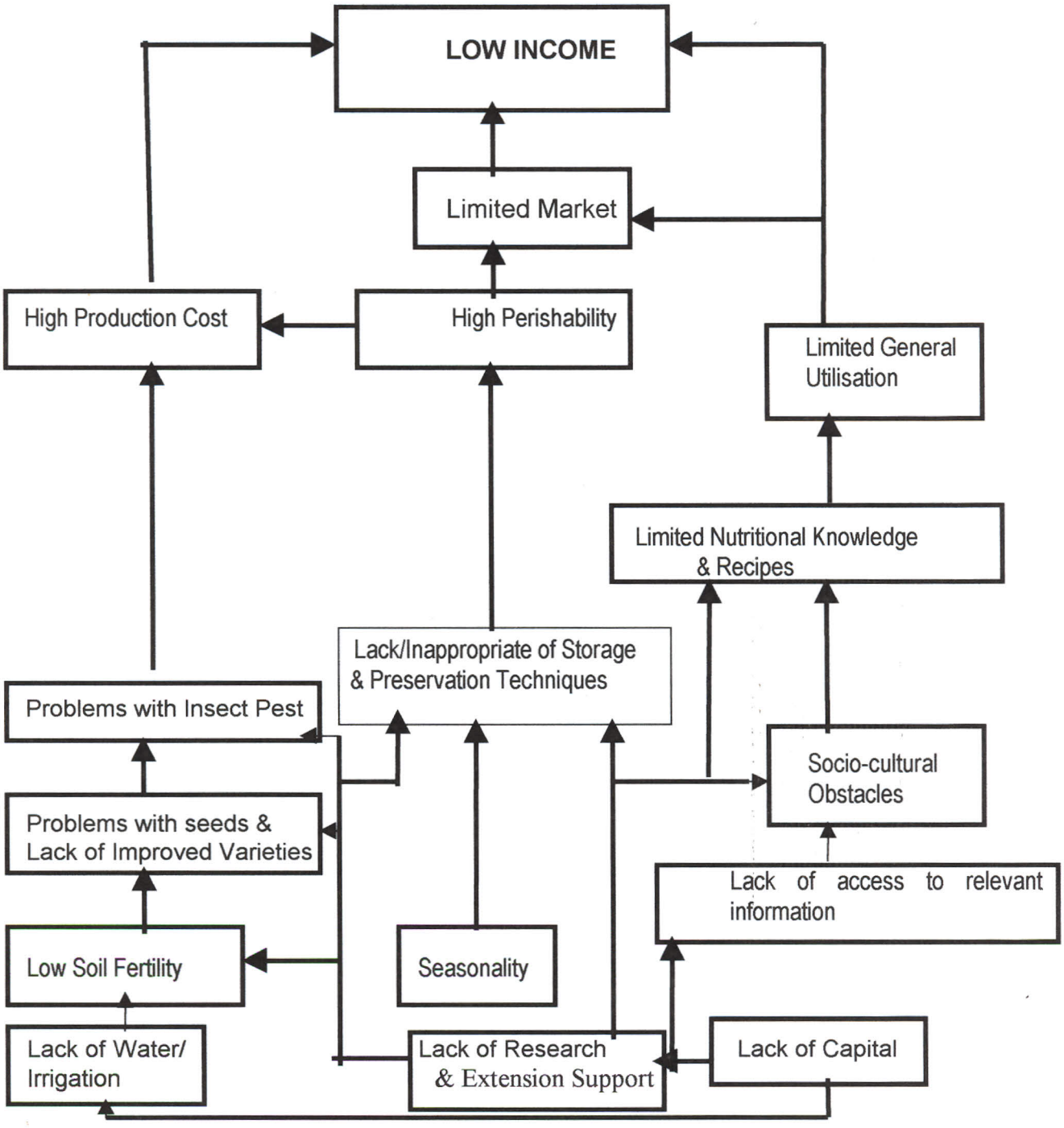
[2] Towns in the Upper-East of Ghana

A garden in Zuarungu in Bawku East District of the Upper East Region of Ghana showing cowpea bean (*Vigna unguiculata*) inter-cropped with *Amaranthus* spp.

A garden in Zebilla in Bawku West District of the Upper East Region of Ghana showing roselle (*Hibiscus sabdariffa*)

ANNEX 10

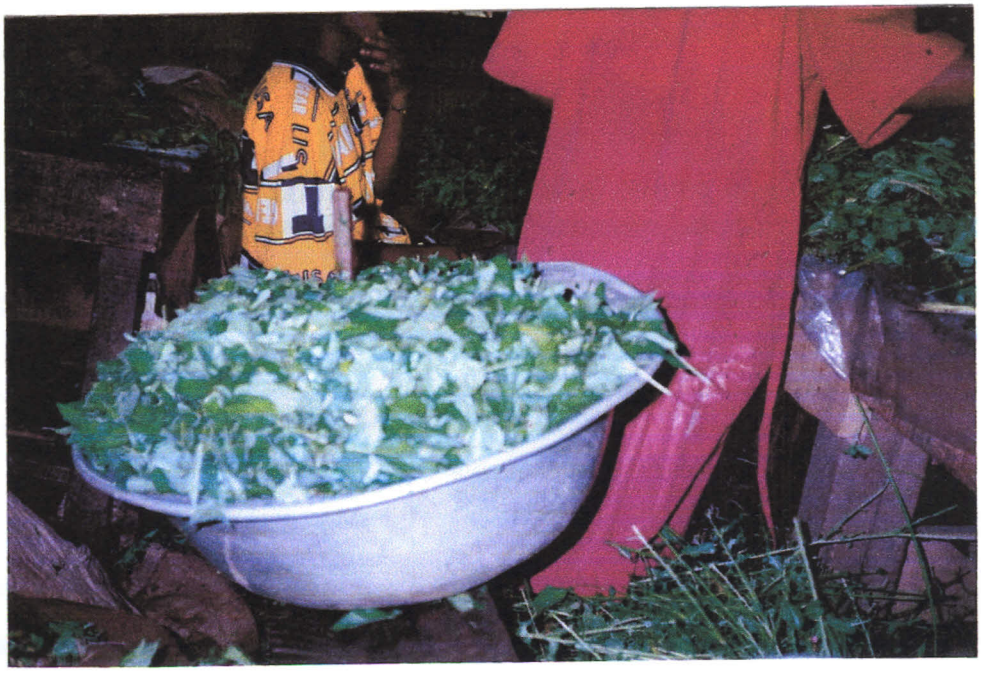
Fig. 7 Problem Tree of the Production, Marketing and Utilisation of Traditional Leafy Vegetables in Ghana



ANNEX 11

PLATES 3 & 4: **Keeping the TLVs fresh and turgid by occasionally sprinkling water over the them**

PLATES 5 & 6: **Fresh cocoyam (*Xanthosoma maffafa*) leaves, popularly called 'Nkontomire' sorted and tied into bundles being sold by the road-side in the Forest zone in Ghana**



Fresh *Ayoyo* (*Corchorus olitorius*) leaves being minimally processed (sorted, washed and chopped into shreds) for marketing at the Kumasi Central Market

ANNEX 12

Table 5

Range of vegetable prices in cedis (¢) at the Tamale markets, Ghana

Vegetable	Unit	Wet season In Cedis (¢)	Dry season In cedis (¢)
Cabbage	sack	40000-50000	60000-100000
Lettuce	Basket/pan	4000-6000	5000-10000
Okra	sack	2000-10000	10000-40000
Cucumber	sacks	4000-5000	5000-40000
Carrots	sacks	11000-20000	20000-70000
Amaranthus spp. (Alefu)	pans	2000-5000	8000-10000
Hibsicus sabdariffa (Bra)	pans	2000-5000	8000-10000
Corchorus spp.(Ayoyo)	pans	2000-5000	5000-16000

Note: In Jan., 2001, $1= ¢7,000

Table 6

Price trends for Cocoyam (Xanthosoma mafaffa) leaves and other TLVs in the Forest zone during and off-season periods

Off- Season Prices	During Season Prices
Cocoyam	*Cocoyam*
At the farm-gate price per bundle 200 cedis ($0.02)	farmgate Price per bundle 100 cedis ($0.01)
retail price per bundle 500 cedis ($0.05)	retail price per bundle 200 cedis
Other TLVs	*Other TLVs*
farmgate price per bundle 2000cedis ($0.20)	farmgate price per bundle 1500 cedis ($0.15)
retail price per bundle 3000 cedis (($0.30)	retail price per bundle 2000 cedis ($0.20)

ANNEX 13

Table 7

Ranking of vegetables as importance source of income at the Tamale markets

Vegetable	Score	Ranking
Tomato	29	9
Okra	8	1
Onion	30	10
Amaranthus spp. ('alefu')	17	5
Hibiscus sabdariffa ('bra')	26	8
Corchorus spp. (ayoyo)	45	11
Cowpea leaves (bangli)	15	4
Sweet pepper	25	7
Cabbage	11	2
Cucumber	18	6
Carrots	18	6
Garden egg	12	3