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AFRICAN INDIGENOUS VEGETABLES

Workshop Proceedings

January 13 - 18, 1997

Limbe, Cameroon

International Plant Genetic Resources Institute
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WORKSHOP

ON

AFRICAN INDIGENOUS VEGETABLES

held in

LIMBE, CAMEROON

JANUARY 13 - 18, 1997

Workshop Papers

Edited by Rudy Schippers and Leonard Budd

Workshop organised by:

International Plant Genetic
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P.O. Box 30677
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FOREWORD

The papers in these proceedings were presented at the Workshop on African Indigenous Vegetables which was held in Limbe, Cameroon from 13-18 January 1997. The workshop was organised by the Natural Resources Institute (NRI), U.K., the Sub-Saharan office of the International Plant Genetic Resources Institute (IPGRI), Nairobi and the Centre for Plant Breeding and Reproduction Research (CPRO-DLO), Wageningen, Holland. The workshop was convened to strengthen existing links between people with an interest in promoting Africa's indigenous vegetables and included horticultural researchers, policy makers, social scientists, botanists and plant breeders.

The initiative for this workshop was a follow-up from a strategy paper on domestication of indigenous vegetables for sub-Saharan Africa (included as an annex to these proceedings). This strategy paper was first presented at a workshop organised by IPGRI and held in Nairobi in August 1996 where a pledge was made to establish information networks, collaborate through exchange of materials and record indigenous knowledge. Utilisation of germplasm and information obtained so far was considered a high priority by the workshop but such activities are not covered by IPGRI's mandate. The objective of the present workshop was therefore to develop a strategy to further promote the use of Africa's traditional vegetables. Such activities include post-harvest handling, processing, marketing and initial plant breeding and selection of varieties which meet those marketing and processing requirements.

Apart from keynote speeches by the three organisers, a total of 18 presentations were made during the plenary meetings, as well as some suggestions for project activities to be carried out in a participant's own country, which have been excluded from these proceedings. On the third day of the workshop, participants had the opportunity to visit the IRAD station at Ekona where a wide range of crops could be seen in home gardens of staff living on the station compound. Several people made use of this opportunity to collect some seeds of unfamiliar varieties. A visit to the local market further confirmed the wide diversity of traditional vegetables that are still in common use by Cameroonians. Finally, the eru market at Idenau was visited where tons of *Gnetum* spp were being prepared for shipment to Nigeria. This crop is currently only collected from the wild. The strong local demand together with export opportunities demonstrate the need for urgency to domesticate this potential new crop in order to reduce forest exploitation of *Gnetum* spp, also known under the local name eru.

The workshop emphasized the need to carry out more research into Africa's own crops rather than finding ways to produce more exotic crops in a hostile environment. Three working groups were established and were asked to prioritise actions required in the near future and to advise on a policy to be followed in their own countries. These working groups combined their recommendations in a final meeting where an action plan was drawn up.

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ADDRESS
PRESENTED TO THE
WORKSHOP ON AFRICAN INDIGENOUS VEGETABLES
LIMBE, CAMEROON
JANUARY 13th 1997

by

Hon. Dr. AYUK - TAKEM JACOB ASSAM,
Director-General,
Institute of Agricultural Research for Development
P.O. Box 2123, Yaounde, Cameroon.

Distinguished participants,
Fellow colleagues,
Ladies and Gentlemen,

On behalf of the Honourable Minister of Scientific and Technical Research of Cameroon, who was not able to be here with us this morning because of other state duties, I will like to welcome you to Limbe which is one of the port cities of Cameroon. Please find some time to discover the beauty of this city. IRAD staff will help you to visit whatever may interest you in Limbe town.

Ladies and gentlemen, I will like to brief you a little bit on Cameroon. Cameroon is one of the countries in Central Africa, bounded on the West by the Federal Republic of Nigeria, East by the Central African Republic, North by Tchad, to the South by Gabon, Congo and Equatorial Guinea and to the South-West by the Atlantic Ocean. Cameroon has a population of about 14 millions spread over 475,000 square kilometres. Altitudes range from zero metres to 4,100 metres on top of Mount Cameroon which is the highest mountain in west and central Africa. The country stretches from latitude 2°N to about latitude 13.5°N and from longitude 9°E to about 16° E. There are about 200 tribes in Cameroon.

Ladies and gentlemen, Scientific research is conducted by the Ministry of Scientific and Technical Research (MINREST) which has five research institutes namely:

- The Institute of Agricultural Research for Development (IRAD)
- The Institute of Medical and Medicinal Plant Research (IMPM)
- The Institute of Geological and Mineral Research (IRGM)
- The National Institute of Cartography (INC)
- Mission for the Promotion of the use of Local Materials (MIPROMALO)

The Institute of Agricultural Research for Development (IRAD) is the largest of the five research institutes and conducts research in five main agro-ecological zones namely :

- The Sudano-Sahelian zone
- The wetter savannah zone
- The highland zone
- The humid forest zone with a monomodal rainfall regime exceeding 3000 mm.
- The semi-humid forest zone with a bimodal rainfall pattern

IRAD's mission is to conduct agricultural (plants and animals) research destined for the development of the country. IRAD has 1,858 staff distributed as follows :

- Researchers = 283 (15.2%)
- Technicians = 365 (19.7%)
- Administrative staff = 124 (6.7%)
- Support personnel = 1087 (58.5%)

The vegetable research programme is one of the most important programmes in IRAD and is conducted mostly in the highland and Sudano-Sahelian zones. Vegetable research is concentrated mainly on the introduced vegetables such as cabbages, lettuce, onions, etc. and very little on the indigenous vegetables. It is of late that IRAD researchers started researching on our indigenous vegetables such as *Gnetum africanum.*

However, because of the diverse ecological zones which do exist in Cameroon, several indigenous vegetables are grown and eaten. Some of them are :

1. *Gnetum africanum,* (popularly known as 'Eru')
2. African spinach (green/amaranths) = *Amaranthus spp*
3. Bitter leaves (perennial) = *Vernonia amygdalina*
4. Fluted pumpkin leaves (*Telfairia spp)*
5. Water leaves (*Talinum triangulare)*
6. Rosselle leaves (*Hibiscus sabdariffa)*
7. Cassava leaves (*Manihot esculenta*)
8. Sweet potato leaves (*Ipomoea batatas*)
9. African eggplant (*Solanum macrocarpon*)
10. Wild black pepper leaves (*Piper spp*) 'Tachot'
11. Cowpea leaves (*Vigna unguiculata*)
12. Baobab leaves (*Adansonia digitata*)
13. Cocoyam leaves (*Colocasia esculenta*)
14. Black night shade (*Solanum spp*)

15. *Corchorus spp.* ('Kren kren' in pidgin English)
16. Native cabbage / Ethiopian kale (*Brassica carinata*)
17. Lagos spinach (*Celosia* spp)
18. Egusi leaves (*Citrullus lanatus*)
19. Edible fern (unidentified species)
20. Minths (Labiatae family) - 'Berem' in Banyangi
21. Pumpkin leaves (*Curcubita* spp)
22. Sweet bitter leaves (annual) - Compositae family.

Fellow participants, The list of indigenous vegetables in Cameroon is in-exhaustive and varies from tribe to tribe. The methods of production, storage and utilization also vary according to the tribes. You may have the opportunity to eat some of them such as 'ndole', 'eru', etc. while here in Cameroon.

Once more, I do welcome you to Limbe, Cameroon and do declare open, the workshop on African indigenous vegetables.

Long live International Cooperation,

Long live Cameroon.

Thank you very much.

PRIORITIES FOR RESEARCH ON AFRICA'S INDIGENOUS VEGETABLES

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INTRODUCTION

For many people in Africa, food means cereals, legumes or starchy root crops and some meat if they are lucky. Vegetables or fruits are considered as just a by-product to add some flavour but are rarely considered as a main source of food. This is possibly why there is still so much anaemia and why many people show vitamin deficiencies. Fortunately, there is increased recognition of the need for micro-nutrients and fruits and vegetables are now promoted through health and nutrition campaigns.

Until recently, vegetables were taken for granted since they appeared to be available in large quantities and people could just collect them either from their garden during the dry season or from the wild during the rainy season. It is therefore not surprising that policy makers did not see the need to spend a lot of money on research to enhance their productive potential. With the introduction of exotic crops which were found to have a better taste, many people living in urban centres started to eat tomatoes, onions, cabbages and others whilst their own traditional crops became stigmatized as old-fashioned food for backward people.

Indigenous vegetables are usually cheap when compared with exotic ones. Therefore they are especially important for people with low incomes in both rural and urban communities. The fact that species such as *Amaranthus* actually flourish on decomposed town generated waste, allows the urban poor access to the micro-nutrients they need and also allows them to bring such crops to the market for sale. Consequently, we now find substantial production of mainly indigenous vegetables right inside major cities throughout Africa. Many of these African vegetables are often far more nutritious than exotics and promotion of the use of such crops therefore appears to be logical.

A widening gap between exotic and indigenous crops

The more research funding is spent on exotic vegetables, the more constraints will be removed, leading to their increased use, which will be at the expense of those crops that do not receive such promotion. Inevitably, the gap between a few popular vegetables, which are consumed on a global scale, and the less well known local ones, is widening all the time. This path will lead to a very limited diversity which is unlikely to benefit people in countries where climatic and other conditions are not normally ideal for such exotic crops. When we assume that food security is rooted in crop diversity, the use of only a few crop species is likely to make us vulnerable for our food supplies in future.

One crop which has received a lot of attention, world-wide, is the tomato, which we used to know by the Latin name *Lycopersicon esculentum*. Modern tomato varieties, however, have genes in them from 7 different *Lycopersicon* species, each providing a desirable characteristic. Gene banks now hold 10 different wild species related to the original tomato which are to be used in new breeding programmes and with genetic manipulation there are now endless opportunities to create even more interesting varieties.

Another example is *Brassica oleracea* which can still be found wild along the coasts of Western European countries. Its domestication history is quite long and this can be seen in the

wide diversity of this 'species', ranging from cauliflower to red cabbage, brussels sprouts to kale and kohlrabi.

Some successful African vegetables

There are a number of African vegetables such as **cowpeas, watermelon** and **melons** which have received a lot of attention, resulting in the removal of undesirable characters and new combinations which express more favoured characteristics. **Garden egg** is a crop seen in many African countries but is virtually unknown outside Africa. It has also gone a long way in its domestication process and there are now many different forms of this crop, ranging from small bitter fruits, used mainly as medicines, to leafy vegetables and fruits used either fresh or in stews. The two species involved, *Solanum aethiopicum* and *Solanum macrocarpon* are related and already crosses between the two are commercially available. There is much scope to further develop these vegetables which are already very important in West Africa.

One of the most popular vegetables in Southeast Nigeria is the **fluted gourd**, *Telfairia occidentalis* of which the leaves are used. This species is most likely to have originated in south eastern Nigeria but is no longer found in the wild. Germplasm is virtually impossible to keep in genebanks because of the recalcitrant character of its seeds. Researchers are keen to develop new varieties that are less restricted by seed storage problems but face difficulties due to lack of diversity in the material available to them. What they apparently don't know is that there is a related wild species found on Mt Cameroon which is rare and in dire need of conservation. Another related species is the oyster nut from East Africa which appears to have less serious seed storage problems and appears to be a good candidate for further studies and breeding work.

Another vine-like vegetable, popular with people in Nigeria, Cameroon and Gabon, ***Gnetum africanum***, is so far only collected from the wild. This has recently led to its disappearance in Nigeria and subsequent export opportunities for Cameroonians who are faced with dwindling supplies from Mt Cameroon. The mountain's long time residents, gorillas and chimpanzees, have relied on this protein-rich food but are now faced with strong competition from the human population. Domestication efforts have been made but are hardly successful due to seed germination problems. It is clearly another crop requiring a research effort before it also disappears completely.

Ethno-botanical evidence has shown that a large number of species which are now eaten as vegetables started off as medicines. The popular **bitterleaf** of which several varieties are no longer very bitter, was originally used by people to overcome stomach pain. Recent observations on chimpanzees in Tanzania, Uganda and Cameroon have shown that chimps swallow whole leaves of *Vernonia* and chew the most bitter part of the plant, the piths of the stems. It was subsequently found that *Vernonia* is a good medicine against worms. Our close relatives, the West African chimpanzees which share 98.6% of our genes, appear to know quite well what nature has to offer and they make good use of it.

Research priorities

To reverse the trend of a downward demand for traditional vegetables due to the availability of tasty exotics, there is an urgent need for a genetic enhancement programme for our local vegetables. One of the first priorities is to select a limited range of crops to be developed further for which we need to know which properties are desirable and which are not. After this, a selection and breeding programme ought to start to make the crop concerned more attractive to consumers and producers alike. In most cases there is ample scope for such an improvement since the genetic resources which are available in the region have hardly been used and have not been studied in detail. Further exploitation through plant breeding efforts ought to get a high priority.

Few vegetables found in Africa's humid tropical zones are grown under high level crop husbandry. In Uganda for instance, priority for allocation of resources to carry out research depends on a crop's export potential. When this is minimal or even zero, there will be no funding and the species concerned will be neglected despite its value in the local community as a source of micro-nutrients. Such husbandry includes nursery techniques, staking or not, establishing nutrient requirements, recommendations for integrated pest management and many other topics.

Seed is only available for a very limited range of varieties and resultant crops are often heterogenous. In turn this means that planting distances are random, thereby affecting crop husbandry in several ways. Heterogeneity also means differences in earliness, yield, taste, fruit or leaf characteristics, tolerances to local stress factors etc. Thus, farmers just cannot exploit the maximum yield potential as they can with modern varieties of exotics.

Product demand

Those pre-harvest constraints will also strongly effect post-harvest issues such as marketing, storage, transportability, presentation and processing. Consumers judge a commodity at the point of sale and are hardly aware of the processes preceding this. The challenge, however, is with us to ensure that the customer is satisfied and that he or she will want the product again.

In tropical parts of Africa, local vegetables are rarely considered as a scarce and valuable resource and hence, no special attention is paid, let alone research funding put aside to enhance their potential. Rather, research funding is now being used to find ways to grow exotics such as tomatoes and cabbages in unsuitable hot and humid environments. In other countries however, and especially in South and Southeast Asia, crops for the lowland tropics are now receiving a lot of attention and as a consequence they become increasingly popular with the public. Many of these crops are easy to grow, are highly nutritious, tasty and, above all, are cheap to produce.

Domestication of new crops

Even though we feel that more attention to domestication efforts is justified, there is certainly no consensus on this from donors. Domestication can be very expensive and we can indeed be talking about several million dollars per species. In the case of *Jojoba* and the winged bean, successes were minimal and they were hardly taken up. I have already received a note stating that our workshop should not be a meeting of the 'Fan Club of the Indigenous Vegetable Society'. A warning has been received from advisers in ODA that we ought to be very sure that our case is based on solid evidence and independent studies showing that there is a significant demand for the products, so that crops which we wish to promote will not go the same way as, for instance, sorghum.

Sorghum was heralded as an African cereal that could tolerate dry conditions and was also said to be popular with people living in arid zones. Subsequently large scale research was carried out, costing millions, and comparatively high yielding varieties were developed. People however still regard it as a crop to be eaten during periods of famine and far prefer to go for either maize or wheat-based food. Donors do not wish to be caught again and are therefore very careful before they embark on a new crop enhancement and promotion programme.

One criterion which is frequently used to determine whether or not a crop is worth further research efforts is by judging the interest shown by seed companies or produce dealers. Investments made by the private sector will ensure interest from all stakeholders, especially if these have been successful. Another criterion will be the outcome of social-economic studies, taking consumer preferences into consideration and commenting on constraints faced by

producers. Market surveys, carried out in different locations, both during rainy and dry seasons, will shed light on each crops' relative importance. Their importance could further be highlighted through comparative studies on nutrients and anti-nutrients.

Our task

We are here this week not only to exchange ideas and experience but mainly to put our thoughts together to be able to advise policy- and decision makers. Given the fact that a domestication process is vey expensive and that funding will be limited, priorities will have to be made. Crops suitable for hot, arid or humid conditions have a comparative advantage over crops that grow well under more temperate conditions where they will meet strong competition from exotics. The choice will be yours to make.

A further note which I would like to make here is that we will need to work on a regional level rather than serving the interests of one or a few countries only. We are so much behind that we just cannot afford to work in isolation. Ideally therefore, suggestions for strategic research funding should be made through an apex organisation like CORAF for West Africa, ASARECA for East Africa or SACCAR for southern Africa. Funding requests with a more limited scope could obviously remain to be channelled through established contacts.

I am looking forward to a successful meeting.

IPGRI; A STRATEGY FOR THE DEVELOPMENT OF INDIGENOUS VEGETABLES

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INTRODUCTION

IPGRI's mandate, spelled out in our strategy document, 'Diversity for Development', is "to advance the conservation and use of plant genetic resources for the benefit of present and future generations.' Based on this mandate, IPGRI has set itself the following four objectives:

- To assist countries, particularly developing nations, to assess and meet their needs for plant genetic resources conservation, and to strengthen links to users
- To strengthen and contribute to international collaboration in the conservation and use of plant genetic resources
- To develop and promote improved strategies and technologies for plant genetic resources conservation
- To provide and international information service on plant genetic resources

In discussing IPGRI's past, present and future work on African indigenous vegetables, I would like to take each of these objectives in turn, though clearly there is some overlap among them.

ASSISTING COUNTRIES

IPGRI has been assisting countries to assess and meet their needs for conservation of indigenous African vegetables since its early days as IBPGR. In 1977, IBPGR published 'Tropical vegetables and their genetic resources', a comprehensive review of the situation. More recently, there have been reviews of the genetic resources of amaranths and okra.

IBPGR has provided support for germplasm collecting for *ex situ* conservation. For example, Lester et al. (1990) summarize IBPGR-sponsored collecting and evaluation of African eggplant germplasm in West Africa. IBPGR was instrumental in the setting up of the Agricultural Research Corporation genebank at Wad Medani in Sudan, which specializes in vegetables. IPGRI has published descriptor lists for eggplant and brassicas and we are considering commissioning descriptor lists for *Solanum nigrum* and *Gynandropsis gynandra*. Of course, collecting and *ex situ* storage is not the only possible conservation option, and a project which aims to assist countries in developing complementary approaches is discussed below.

INTERNATIONAL COLLABORATION

Turning to the fostering of international collaboration, in August 1995 the IPGRI-Sub-Saharan Africa office and the University of Nairobi organized a workshop on 'Genetic Resources of Traditional Vegetables in Africa: Conservation and Use'. The specific objectives of the workshop were:

- To exchange information on the conservation and use of genetic resources of traditional vegetables in different African countries.

- To identify gaps and constraints in the conservation and use of traditional vegetables in Africa.
- To investigate ways of forging links among plant genetic resources researchers working on these species, and between them on one side and social scientists, nutritionists and development workers on the other.
- To discuss collaborative initiatives for the conservation and use of traditional vegetables in Africa.
- To develop a regional strategy for the conservation and use of genetic resources of traditional vegetables in Africa.

The genesis of the workshop lies in two of the recommendations of the CTA/IPGRI/KARI/UNEP seminar held in October 1992 in Nairobi under the title 'Safeguarding the genetic basis of Africa's traditional crops'. One recommendation was that more attention should be paid by the plant genetic resources conservation community to hitherto relatively neglected species, in particular indigenous vegetables and other so-called 'minor' crops. Another recommendation was that more research was needed on the role played by home and kitchen gardens as repositories of biodiversity, and hence on the role of women as curators and managers of genetic resources.

Over 20 researchers from countries all over Africa participated in the 1995 meeting, representing regional organizations, government institutes, universities and NGOs. They presented papers describing their activities in the conservation, marketing, breeding and agronomy of traditional African vegetables. It was decided by the workshop that some kind of network on African traditional vegetables would serve a useful purpose. However, it was thought necessary to first develop a list of existing relevant activities and initiatives. IPGRI offered to produce a database of traditional vegetable workers, institutions and networks. A committee consisting of Prof Chweya (Chair) and Drs Okafor, Diouf and Swai was established to coordinate follow-up activities to the workshop. The proceedings of the workshop will be published soon by IPGRI.

STRATEGIES AND TECHNOLOGIES

Working with countries to develop strategies for the conservation of agricultural biodiversity and plant genetic resources is at the centre of IPGRI's mission. In developing conservation strategies, IPGRI has largely concentrated on *ex situ* approaches by helping to establish national and regional genebanks and supporting their activities. More recently, a complementary, *in situ* approach has been increasingly considered that aims to conserve agricultural biodiversity and crop genetic resources in their habitats i.e. the agro-ecosystems managed by farmers and agrarian communities.

Many of Africa's traditional vegetables, particularly the leafy green vegetables, are weedy, semi-cultivated species, or crops requiring very little in the way of management and inputs. Kitchen and home gardens, fallows, watercourses, field margins and disturbed areas along the rows of staple crops are typical of the kinds of sites where these species are found. They thus occupy isolated, hidden, fragmented, ephemeral micro-environments. They are often managed, used, and sold by women and in some cases by children. For these and other reasons they have been neglected by the formal scientific and development system, though they are important in local production and consumption systems.

IPGRI's interest in neglected crops in general and Africa's traditional vegetables in particular is leading to the crystallization of a third complementary element of an overall conservation strategy, namely conservation through promotion and increased use. This approach focuses on the production and consumption systems for traditional crops. It looks at the agronomic,

economic and cultural factors that constrain the expansion and competitiveness of these crops, and tries to identify ways of overcoming these barriers in order to ensure that useful genetic diversity is not lost forever.

An IPGRI project proposal addressing these issues, 'The Biodiversity of Neglected Leafy Green Vegetable Crops in Africa' was discussed at the 1995 Nairobi workshop and partners identified. The proposal, refined and finalized on the basis of these discussions, and of the recommendations of the workshop, was submitted to various donors. It was accepted for funding by The Netherlands in mid-1996.

Preliminary work on the project centred around the development of draft protocols for survey work, in particular focusing on indigenous knowledge, nutrition and socio-economic factors. Key partners in Kenya (from the National Museums and the University of Nairobi) participated in this process. This was followed by a research planning meeting held in Nairobi on 28-30 August 1996. The participants were researchers from 5 countries (Kenya, Botswana, Zimbabwe, Senegal and Cameroon). There were observers from the Dutch genebank and from NRI. The meeting resulted in draft proposals for surveys in each country of the genetic diversity of traditional vegetables, focusing on farmer perceptions, taking due account of gender differences. The work will attempt to document the contribution of these species to nutritional and household income (in particular women's income), indicate whether use is declining and why this is happening, and identify genetic diversity which could overcome constraints to increased use. It was expected that the survey work would commence in most countries before the end of 1996. Preliminary work has already started in Kenya.

INFORMATION SERVICE

One of the key activities of IBPGR, and now of IPGRI, has been gathering information on existing *ex situ* germplasm collections. A directory of vegetable collections worldwide came out in 1990. The data it contains is also maintained in databases which are regularly updated. More recently, IPGRI has also been supporting the preparation of monographs of key species through a GTZ-funded special project. Prof. J. Chweya of the University of Nairobi is preparing monographs on *Solanun nigrum* and *Gynandropsis gynandra* for this project, the latter in collaboration with Dr Mnzava. Also part of the project is the development of a generalized approach to the conservation of crops that are neglected by the scientific community and/or underutilized by farmers.

Various recommendations of the 1995 Nairobi meeting have an information component:

- Filled-in questionnaires have been received and the information will be incorporated into IPGRI databases (country profiles, mailing list). A directory will be produced.
- Editing of the proceedings is almost complete. They should be published before the end of 1996.
- The SSA Regional Newsletter has begun to play this networking role. The last issue included the participants' list and the recommendations.
- A bibliography of IPGRI publications on African indigenous vegetables has been produced and circulated to all participants. A database search was also conducted and some 420 publications included in a bibliography which is being reviewed by Dr Mnzava.

CONCLUSION

We see this meeting as continuing and strengthening the networking started by the 1995 meeting, an opportunity to report on some of the activities we have been undertaking in following-up the recommendations of that meeting. We also see it as an opportunity to move forward, in partnership with national programmes and the co-sponsors, in developing a coherent and comprehensive strategy for the conservation of the genetic resources of indigenous African vegetables including a strong component of promotion of use.

DEVELOPING THE POTENTIAL OF LOCAL VEGETABLES USING EXPERIENCES FROM AFRICA AND SOUTH-EAST ASIA

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SUMMARY

The development of local vegetables in Africa is far behind that of South-East Asia. Experiences with home-garden projects in west Africa following the Indonesian model and with research on lowland vegetables in Indonesia, indicate the large potential for raising the yield levels of local vegetables with a consequent improvement in human nutrition and farmers' incomes. It is recommended that the social status of local vegetables should be raised and that plant breeding and seed production by farmers and the private sector should be stimulated. The serious risks of genetic erosion in local vegetables may be reduced by stimulating their utilization and improving their productivity.

LOCAL VEGETABLES VERSUS EXOTICS

The objective of this workshop is to study the position of indigenous vegetables as an under-utilized and neglected group of food crops in Africa, and to discuss strategies to realise their potential for improving the livelihood of the less endowed on this continent. 'Indigenous' in the botanical sense means that the species originated from the wild vegetation of that area. However, many old introductions which have been cultivated for many decades may also be called 'indigenous'. A better term for all vegetable species commonly grown in a certain area by generations of farmers and propagated as landraces is therefore traditional or local vegetables.

In Africa, in addition to numerous indigenous vegetables (*Celosia, Corchorus*, amaranth, fluted gourd, bitter leaf, egoussi, African eggplant, Ethiopian kale etc.), many old introductions, such as hot pepper, tomato and pumpkin from Latin America, shallot from west Asia and cucumber from India, have become part of the tradition. Species such as onions and carrots from west Asia, French beans from Latin America and Indian okra have become traditional in some areas but are exotic in other areas.

The international vegetable market is dominated by a relatively small number of 'international' vegetables which have a modern and advanced, high value image e.g. white cabbage, cauliflower, broccoli, iceberg lettuce, sweet pepper, tomato, eggplant, cucumber, carrot, Irish potato, melon and watermelon. The producers of these crops in Western countries use very high input levels and high-tech cropping systems. Consequently, the commercially available varieties are high-input varieties with a high yield potential and require a considerable level of expertise in farm management. Huge amounts of money are invested in research and plant breeding programmes for these crops by Western-based research institutes and seed companies. Public institutions and seed companies in African countries tend to follow this trend, spending funds and efforts on the introduction of international, exotic vegetable species and cultivars, thereby neglecting the use of local vegetables. More and more producers grow these exotic vegetables which are poorly adapted to their conditions. They require high inputs of fertilizer and pesticides and are sensitive to stress. The high investments requiredand risk related to the cultivation of exotic species does not fit into the economic conditions of poor rural and urban households. Furthermore, in the cities, exotic vegetables have found their

place in the kitchen and the diet, replacing traditional dishes. The replacement of leafy vegetables by, for instance, white cabbage, has impoverished the nutritional composition of the diet.

EXPERIENCE OF THE FAO HOME GARDENS PROJECTS 1964 - 1975

Terra, a Dutch horticulturist known for his pioneer research on the Indonesian backyard ecosystem, started home-garden projects in Nigeria (Ilesha) and in Benin (Porto-Novo) in 1964 with the strong involvement of CPRO-DLO. The objective was to promote the Indonesian concept of home gardening in Africa in order to improve human nutrition by using local vegetables to supply essential micro-nutrients and proteins to the peoples' diet. These two projects greatly stimulated national and international attention for traditional African vegetables. Conclusions from the two projects were:

- The principles of home gardening are the same in Africa as in Asia, i.e. no external inputs (purchased seed / special tools / mineral fertiliser / pesticides); mixed cultivation of vegetables, fruits and other useful species (maize, cassava, medicinal plants etc.); often in combination with small livestock; fertilization by recycling of organic waste.
- Intensive participation of local people, especially women, in the project set-up is needed, thereby making maximum use of their experience.
- Success of home gardening is based on traditional vegetables; introduction of new species (exotics) is not needed.
- Vegetable consumption is promoted by nutritional education of teachers (for school gardens), rural extension workers and health workers (demonstration gardens at health centres).
- The establishment of demonstration / experimental home gardens in the villages and the supply of planting material stimulates production of vegetables.
- At present, enough knowledge is generated by research and experimental work to start or promote the production of local vegetables in home gardens. However, support from research organisations is useful.

LOCAL VEGETABLES IN SOUTH-EAST ASIA: INDONESIA

Commercial production of traditional vegetables

About 60 % of Indonesia's population of 200 million people is used to buying vegetables at street markets. The per capita vegetable intake (at present 110 g/day) is increasing. The top ten lowland vegetables, commercially grown on 600,000 ha, are hot pepper, yard-long bean (*Vigna unguiculata ssp. sesquipedalis*), shallot, red kidney bean (*Phaseolus vulgaris*), cucumber, eggplant, amaranth, kangkung (*Ipomoea aquatica*), caisin (*Brassica rapa*) and pumpkins / gourds. In highland (above 700 meters) the top ten vegetables, grown on 200,000 ha, are cabbage, potato, tomato, Chinese cabbage, chayote (*Sechium edule*), welsh onion (*Allium fistulosum*), French bean (*Phaseolus vulgaris*), garlic, carrot and Chinese radish. These 20 species, all traditional for more than a century, make up at least 80% of the total sales, whereas all the other 100 species make up only 20%. Highland vegetables, mostly the European type, show a much higher yield level than the indigenous lowland vegetables. The farms are very small, on average < 0.25 ha and farmers use some mechanization (e.g. motor pumps for irrigation) and high inputs (pesticides and fertilizer).

From 1987 to 1992 CPRO-DLO executed a bilateral DGIS-funded project "Strengthening of Research and Development of Lowland Vegetables in Indonesia", as support to the Research Institute for Vegetables (RIV) at Lembang. A gene bank was set up and much research for

breeding and improvement of cultural practices of lowland vegetables was started, following the ISNAR model of On-Farm Client-Oriented Research (OFCOR). Much knowledge has been generated which can be applied by the farmers.

At present, as a consequence of strong urbanization and fast economic development, commercial vegetable farming is a booming industry. The consumption of vegetables shows a strong positive income elasticity. There is a remarkable expansion of plant breeding activities in the private sector. Local seed companies (such as East-West Seed Company, Selektani, Benih Prima) are developing and are making much progress in breeding all kinds of commercial vegetables, local as well as exotic, the seed supply is almost adequate and average yields of local vegetables are on the increase. Farmers are changing from using their own seed to seed produced by new Indonesian companies. Their cultivars, mostly selections from landraces, are well adapted to the ecosystem and F1-hybrids are becoming more and more popular.

Foreign cultivars are used only for cabbage and some less important species (sweet pepper, asparagus); almost all such seeds are imported from outside the SE Asian region. However, also for some local vegetables e.g. kailan, caisim, Chinese radish, welsh onion, bulb onion etc. an increasing part of the market seed is produced outside the South-East Asian area to lower the production cost. Vast vegetable production areas with skilled professional vegetable farmers have developed in the peri-urban areas.

Conservation of biodiversity through utilization

The number of local vegetable species in south-east Asian countries is extremely high. At a common street market in Jakarta, the buyer may choose from some 120 species. Many of the traditional vegetables are grown in the fields or harvested from trees and shrubs in the home gardens. Only a few species are gathered from the wild vegetation. Local varieties of traditional vegetable species which are propagated by seed and vegetatively propagated local vegetables (clones), together form a group of food plants with a high agricultural significance and genetic variation. Thus, utilization of these genetic resources is a way of *in situ* genetic conservation, both by commercial growers and in home gardens, complementary to *ex situ* storage of plant materials.

Another support to in situ conservation of this vast source of biodiversity is the promotion of home gardening (also peri-urban and urban) and field production of vegetables by public programmes and NGO's. In this respect, the stimulation of utilization of biodiversity serves conservation as well as improves family nutrition and income.

The genetic erosion in all species for which farmers use commercial seed is alarming and many valuable landraces have already disappeared for ever. Associated with the loss of genetic diversity is the loss of knowledge on their utilization. Knowledge on the ecology and utilization of these vegetables and their preparation tends to go lost even faster than the plants themselves. These threats seem more serious for Africa than for Asia, since in Asia the position of the traditional vegetables is much stronger, particularly that of the commercially produced ones. Furthermore, the traditional food crops have a cultural value which is easily overlooked, not only by policy makers and donors, but also by the people themselves.

Research and breeding of local vegetables in South-East Asia

In the past, most public research funding for horticulture in South-East Asian countries was spent on a very limited number of highland vegetables of European / Chinese origin and indigenous species were neglected. At present, research funding is more evenly spread over about 20 commercially important species but traditional vegetables with a low market value do not get much attention from the public sector.

The big international seed companies are not interested in these crops because a market as diverse as the one for local vegetables is difficult to penetrate. This market is very diverse with regard to the range species that are utilized, the agro-ecological conditions in which they are grown and in consumers' preferences. However, over the last decade, several small seed companies based in South-East Asia have been able to enter the market for traditional vegetables. Thanks to the rich genetic resources locally available for breeding, supported by experience in the seed business gained from western international companies, and driven by a high demand for reliable seed, these new companies are rather successful and have a rapidly increasing impact on vegetable production in that area.

A STRATEGY TO DEVELOP THE POTENTIAL OF LOCAL VEGETABLES

We may give some reasons to further explore the potential of traditional vegetables in Africa and why it merits further development;

- the importance of vegetables for nutrition
- the potential of vegetables for income generation, particular for women
- the high input requirements and vulnerability to pests, diseases and stresses by the 'exotics'
- potential for yield improvement through genetic improvement
- the threat of genetic erosion
- the cultural importance of diets.

The entire group of traditional vegetables may be sub-divided into three groups;

- species grown primarily to generate cash income
- species grown exclusively for home consumption
- species collected from the wild vegetation or disturbed habitats (weeds, potherbs).

The first and second overlap to a large extent. However, in trying to develop their potential through improving seed supply and cultivation practices, it is essential to realise that farmers' decisions regarding cash crops are different from those for home consumption.

Each of these groups of vegetables is very diverseand the importance of the different species and their utilization varies from place to place. Aspects that need to be addressed in the last two groups are:

- ways to raise awareness and status of the vegetables
- evaluation and selection of better performing types
- improving cultivation practices (planting, fertilization, pest and disease control)
- processing
- preservation
- marketing.

The genetic diversity of the group of species and varieties, the variation in their importance, agro-ecological conditions in which they are grown and the consumer preferences, makes working in an integrated manner on all the above points extremely complex. It has been shown that institutionally it is difficult to cope with such diversity and that such situations require a participatory approache (Chambers et al., 1989; Haverkort et al., 1991). There are good examples showing that on-farm evaluation and selection of plant material by farmers is

more effective than when breeders do so on-farm; it combines local adaptation of the materials with farmers' preferences and criteria. Defining and improving cultivation practices on-farm in collaboration with farmers, generates better adapted technology since the total of farmers' considerations on crop management are taken into account from the start.

Seed production is another activity in which farmers' abilities are well-recognised (De Boef et al.,1995). While increasing the effectiveness of the activities and being more cost-effective, such participatory approaches empower farmers to improve their own situation.

However, participatory development of traditional vegetables needs the support from co-ordinated activities by researchers in the public sector. Exchange of materials for evaluation of performance and breeding activities that go further than mass-selection, require inputs from specialists. Seed production or propagation in general is another area that may need more fundamental research in specific vegetable species or varieties. The development of cutivated traditional vegetables thus requires activities in which many specialists have a role to play; scientists, extensionists, NGO's, farmers, policy makers and private seed companies.

SHOULD WE ACTIVATE DOMESTICATION?

A small number of the originally very large number of indigenous vegetables collected from the wild vegetation or grown in home gardens for subsistence, have become widely cultivated as cash crops. Only few species met the desired characteristics for commercial production; easy cultivation and harvest, high yield level, good taste and fitting in with local production system and food habits. Many of the wild or semi-domesticated traditional vegetables are locally important in subsistence agriculture or home gardens but have less chance to reach the stage of commercial production. Should we select some of them and give a hand to the domestication process, bring them on the road towards commercial production? If there is a real nutritional or economic need, the answer is: yes. However, how can that need be defined?

The daily quantity of vegetables needed in a balanced diet depends on the composition of the total menu. In general terms, a portion of 50 grams of darkgreen leaf vegetable and 100 grams of other vegetables will provide enough micro-nutrients for an adult person. Because vegetables vary in micro-nutrient content, consumption of a wide range of species is important. In South-East Asia this variation is amply available in the existing assortment found in local markets and there is not much need to increase the variation. However, in most places in Africa the range of vegetables is rather restricted.

A positive argument for domestication is that, faced with a larger choice, people in Africa will be inclined to consume more vegetables

Several wild and semi-domesticated vegetables may be important for food security i.e. filling gaps in food supply between the start of the rainy season and the harvest of the field crops. In areas with a high population pressure, the position of these usually collected plants may be threatened. Apart from safeguarding these plants in ex-situ collections, possibilities to bring these specimen into cultivation could be significant for the conservation of the species and for food security. Activities targetting this group of plants require a strong collaboration between farmers and researchers, as it depends on farmers' criteria what place the cultivation of these plants, as opposed to the traditional collection, can take in their production system. For example, how much land and labour can a farmer handle and how to fertilize are questions that can only be answered by the farmer. How and when to sow, produce seed and select genotypes require experimentation which to a large extent can be carried out on-farm.

CO-OPERATION WITH WAGENINGEN

The Centre for Plant Breeding and Reproduction Research (CPRO-DLO) has a long experience in vegetable breeding and handling of germplasm of many traditional and exotic vegetable species in Europe. At present, there is a strong collaboration with Indonesia in a breeding programme entitled 'Biotechnology, Plant breeding and Seed Technology for Horticulture' (BIOBREES), with shallots and hot pepper as the main local vegetable species.

CPRO-DLO is one of the partners of the international multi-donor Community Biodiversity Development and Conservation (CBDC) programme. The African partners are NGO's from Zimbabwe and Kenya (CUMMUTECH and CIKSAP respectively), the Ethiopian Biodiversity Institute, and the Rice Research Station Rokupr in Sierra Leone. The objective of the programme is to stimulate collaboration between formal and non-formal agricultural research systems for in situ and ex situ conservation and development of genetic variation, needed for more food security.

The central focus is the local system and the role of farmers in the whole process of conservation and utilization of plant genetic resources. The starting point is the recognition of the value of the local system and the capacities of farmers to reproduce crops and safeguard biodiversity. Next to cereals, carbohydrate tubers and pulses, attention is given to local vegetables, medicinal herbs and other plants used by rural people. Diverse agro-ecological environments and socio-economic and cultural conditions in relation to a number of issues are addressed; the loss of habitats by increasing population pressure, the consequence of urbanisation for the collection of wild vegetables and for subsistence farming, how to avoid genetic erosion, the position of the farmers in international property rights and the participation of farmers in varietal improvement.

Together with the Wageningen Agricultural University (WAU) and the International Agricultural Centre (IAC), CPRO-DLO is partner in Wageningen Seed Centre (WSC), which cooperates with many international institutes for training and research in all fields related to plant breeding, seed technology and seed related issues.

Plant Resources of South East-Asia (PROSEA) is a cooperative programme of Wageningen Agricultural University with NARs of Indonesia, Malaysia, Vietnam, Thailand, Papua New Guinea and the Philippines for the publication of knowledge on about 8.000 useful plant species. Volume 8, entitled 'Vegetables', describes 800 plant species yielding vegetable products, with about 100 detailed treatments. This volume serves as a reference for national and international research programmes. Reference to the taxonomic part of this volume would avoid many taxonomic mis-interpretations.

Several research institutes and departments of Wageningen Agricultural University cooperate with the Asian Vegetable Research and Development Center (AVRDC) established in Taiwan. AVRDC has a leading role in the network of research and training activities and provides support to NARs in South-East Asia. Through the African base of AVRDC (Arusha, Tanzania), this Asian network is approachable for African researchers. AVRDC is a (potential) partner for Wageningen in setting up research cooperation with African organizations.

CONCLUSIONS

More research and development of local vegetables will result in strongly improved yield levels with a beneficial effect on farmers' income. The increased production of vegetables for home consumption and for marketing will improve human nutrition. The consumption of green leafy vegetables, which have the highest nutritional value, will especially add to the nutritional status of poor rural and urban households. Cultivating more local instead of exotic

vegetables means a better adaptation to the ecosystem and may restrict the need for pesticides. Maintenance of the complex of traditional vegetables means in situ conservation of the rich diversity of genotypes of importance for future generations.

Initiatives for further exploitation and development of local vegetables are expected from the African communities and public sector concerned. The stimulation of co-operation in plant breeding activities between the public sector and private seed companies is vital. Because the market for vegetable seed in most countries is too small to attract private seed companies, a regional / international approach is needed.

CPRO-DLO is able to co-operate with and to join international initiatives for the promotion and development of traditional African vegetables. It is able to assist with the planning and development of collaborative activities involving farmers, NGO's, national scientists and seed companies, as well as training and research in biodiversity management, fundamental and applied plant breeding, application of biotechnology, production of improved planting material and formulation of seed legislation.

SCOPE AND HIGHLIGHTS OF RESEARCH ON INDIGENOUS VEGETABLES OF SOUTHERN AND EAST AFRICA

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The Africa Regional Program (ARP) of the Asian Vegetable Research and Development Center (AVRDC) extends into Africa its general mission, which is "to enhance the nutritional well-being and raise the income of rural and urban poor in the developing countries through improved methods of vegetable production, marketing and distribution, taking into account the need to preserve the quality of the environment".

ARP carries out the following general mandates for the benefit of the African national programs: research, training, genetic resource activities and information services. ARP works in collaboration with African NARS to;

- conserve and enhance the genetic resources of selected vegetables
- develop improved varieties and sustainable production technologies
- disseminate relevant vegetable research information
- train promising African vegetable researchers
- strengthen the national research institutions in the region

ARP presently undertakes two major projects, supported by the Federal Republic of Germany through BMZ/GTZ, namely;

- Tomato Genetic Improvement Program for the African Highlands
- Collaborative Network For Vegetable Research and Development in Southern Africa (CONVERDS).

In addition, ARP receives limited core support to carry out some research into African indigenous vegetables and on the Center's global commodities, particularly solanaceous species (tomato, eggplant and capsicum), bulb alliums (onion, garlic and shallot), and crucifers (common cabbage and Chinese cabbage).

With the exception of tomato for which a full-scale breeding program is currently being conducted, the scope of research is generally focused on germplasm introduction and evaluation, development of improved production practicesand disease identification and management.

Perspectives on indigenous vegetables of Southern and East Africa

Eastern and Southern Africa feature a range of agro-ecologies that represent most parts of the African continent. They include both highlands and lowlands. In this sub-region there is a wide range of indigenous vegetables and most of them are yet to be domesticated. The most popular indigenous vegetables recorded in Eastern and Southern Africa include amaranth, African

eggplant, black nightshade and Ethiopian mustard. However, there is a lack of quantitative information on their distribution, their diversity and their relative importance in the sub-region across the target crops in vegetable-based cropping systems and among the countries. There is also scant and fragmentary information on the production technologies of indigenous vegetables in the region. The different abiotic and biotic factors affecting the production of indigenous vegetables are also yet to be identified.

This research brief presents the scope of ARP's research activities on the indigenous vegetable species of Southern Africa and highlights of studies that have been conducted since 1993.

Genetic resource activities

African eggplant (*Solanum aethopicum*) Eleven varieties which have been collected and maintained by Horti-Tengeru in the past decade were briefly described and named, and their seeds collected for further evaluation.

Evaluation trials of introduced germplasm of some indigenous vegetables; e.g. amaranth have also been conducted at ARP. In a replicated field trial comparing 82 Taiwan commercial amaranth cultivars with the local cultivars which are widely grown in Tanzania, the Taiwan varieties proved to be weaker, slower growing, and lower yielding than the latter. Tanzania Red (*Amaranthus hypochondriatus*) grew the fastest and yielded the highest among the four local cultivars. A number of promising germplasm of other indigenous vegetables have been identified and multiplied for further tests in Tanzania and other SADC's (Southern African Development Council) NARS.

Ethiopian mustard A small experiment for plant vigor and apparent tolerance to Turnip Mosaic Virus (TuMV) in Ethiopian mustard has been carried out on heterogenous local populations that are popularly grown in Tanzania. S1 progeny testing for plant vigor and anthocyanin pigmentation and reconstitution of new base populations by intercrossing horticulturally similar types led to the development of new base populations. Evaluation of these new base populations indicated that one, Mbeya Green, yields twice as much and has longer harvest duration, and thus, longer productivity period, than the local populations distributed by Horti-Tengeru. The improved Ethiopian mustard populations are now being distributed to our collaborators in the SADC region.

Agronomic experiments

Management experiments have been conducted since 1993 on the following indigenous vegetables: amaranth, black nightshade, African eggplant and Ethiopian mustard. The studies ranged from cultivar description, fertility and spacing experiments, effect of removing of apical dominance on plant development, influence of stress on duration of harvest and yield, fertility levels, etc.

Yellow nightshade (*Solanum pseudonigrum*) A study of the effect of within-row spacing and time of topping and de-flowering on leaf, fruit and seed yield of yellow nightshade showed that the optimum spacing was 20 cm between plants on 60 cm ridges. Total yield of 5t/ha was obtained after six bi-weekly harvests. Close spacings were significantly superior. Early topping or deflowering did not influence yield nor were there consistent interactions between the tested variables on individual harvest. However, late topping favored an increase in total leaf, fruit and seed yield whereas deflowering reduced it, particularly on closely spaced plants.

Ethiopian mustard (*Brassica carinata*) Investigations on the effect of within-row spacing on leaf yield showed that significantly higher yield (up to 37t/ha) was obtained at spacings of 30-45 cm between plants. Application of 150 t/ha farm yard manure gave the highest leaf yield of 42 t/ha in Ethiopian mustard. However, this rate was obviously very uneconomical.

African eggplant A study on the effect of early loss of apical dominance on yield and other characters showed that pinching (or topping) to encourage more branch formation did not influence the yield and other characters regardless of cultivars. The variety Tengeru White was found to be better than Manyire Green in yield, fruit size and plant canopy. It also tended to have taller plants and more fruit clusters than Manyire Green. Therefore, topping of African eggplant is not a worthwhile practice to recommend to vegetable producers.

Black nightshade The effect of spacing and nitrogen on yield showed that all nitrogen treatments significantly outyielded the unfertilized plot, with leaf yields ranging from 19 to 21 t/ha, or about twice as much leaf yield as the control. The best yielding nitrogen-spacing combination was 200 kg N/ha at 30 x 30 cm spacing, giving a leaf \\\yield of about 28 t/ha. Lowest yield was recorded in the unfertilized plot combined with wider spacing.

Diseases Preliminary study on the identification of major diseases of indigenous vegetables was also conducted. Black leaf mold caused by *Pseudocercospora fuligena* was found to cause extensive damage to black nightshade in Tanzania. Three major virus diseases namely, cucumber mosaic virus (CMV), potato virus Y (PVY) and tobacco mosaic virus (TMV) were identified on blacknightshade. Turnip mosaic virus (TuMV) is widespread in lead SADC countries and causes serious damage on the Ethiopian mustard.

Scope of future research and development activities

Based on preliminary work at ARP, future activities will focus on the following areas;

- **Germplasm collection and evaluation** This activity will be continued with a region-wide survey of major species to be undertaken and germplasm collected, characterized and evaluated.

- **Seed production and distribution** There is an urgent need to develop a functional seed production scheme for the major species to enable the African NARS to have access to the best possible germplasm.

- **Management systems** Thus far, very little research work and scant information are available on improved production practices of indigenous vegetables. For instance, the effect of practices such as hardening, pinching etc on premature bolting of Ethiopian mustard needs to be studied. ARP intends to generate useful information on production procedures of the major species.

Postharvest practices There is a huge 'relish gap' period when the supply and consumption of the indigenous vegetables are low. Postharvest preservation practices that will prolong their availability need to be developed.

DOMESTICATION STRATEGY FOR UNDERUTILIZED AFRICAN VEGETABLES

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INTRODUCTION

African traditional societies have in the past, and even now, utilized wild and non-cultivated vegetables to meet their adequate nutritional status. Dietary utilization of these non-domesticated African vegetables has received little attention by agricultural research systems and this has led to narrowing of the food base in many traditional societies. There has been a lot of emphasis on the production and consumption of exotic vegetables which has led to the neglect and underutilization of African traditional/indigenous vegetables. Most of these vegetables grow as weeds in the wild and/or cultivated areas, are semi-cultivated or are crops that require very little agromanagement and agro-techniques.

These vegetables are found in kitchen/home gardens, fallows, disturbed areas, watercourses and field margins. They occupy isolated, hidden fragmented and ephemeral micro-environments. If not completely domesticated, the species could be in a vulnerable position to be destroyed by drought, and other environmental factors such as deforestation and devegetation due to human settlement and urbanization and mono-culture cropping systems. Domestication and conservation of the vegetables is essential to increase the food base in both rural and urban areas in African countries. This will lead to ensuring dietary balance and intake of micro-nutrients.

WHY DOMESTICATE AFRICAN VEGETABLES?

African traditional/indigenous vegetables have an important and essential role in African agricultural and nutritional systems. Each country in Sub-Saharan Africa has documented evidence of species which are reportedly used as vegetables. The vegetables are used in the preparation of relishes used to supplement and/or add flavour to diets which are based on starchy staples. Green leafy vegetables are added to stews or soups which accompany the staples. Many rural communities in Sub-Saharan Africa have developed sophisticated recipes based on traditional vegetables. Such vegetables are nutritious and hence play a major role in maintaining the nutritional well being of rural communities.

They supply much, if not most, of the required vitamins (especially A, B and C), minerals, fibre, carbohydrates and proteins. It is now known that if these vegetables are grown under appropriate agromanagement, they can effectively provide, at low input levels, minimum nutritional balance needed by local populations. Studies have shown that leaf yields of some indigenous green leafy vegetable species could be as high as, or compare well with, exotic types. Indigenous/traditional crops are normally adapted to local environmental conditions. Indigenous/traditional vegetables may therefore be tolerant/resistant to abiotic and biotic stresses found locally. They are known and popular and hence promoting their consumption in both rural and urban areas, maybe easier than promoting the use of exotic types. Exotic types are expensive to grow or buy as they require advanced and expensive agro-techniques. Rural communities are, therefore, unable to buy and use the exotic vegetables and this may lead to undernourishment. Studies have shown that indigenous/traditional vegetables are as nutritious as, or more so than, exotic ones. From the foregoing, it is clear that there is a case for encouraging and supporting continued domestication of African vegetables.

DOMESTICATION STRATEGY

African vegetables have often been given low priority in most agronomic research and development programmes. This is principally because their total yields, sales and contribution to household nutrition have not been properly documented. The vegetables are hence regarded as very minor crops by formal researchers and policy makers. There are, therefore, very few systematic studies conducted on these plant species. There has been minimal documentation about their indigenous knowledge of utilization and cultivation techniques, extent and structure of genetic variation and potential for improvement as crops through adaptation, selection and breeding initiatives. Most of the vegetables are treated as wild plants or weeds by researchers such as agronomists, breeders and policy makers. However, these plants are very important in local production and consumption systems. Their domestication and cultivation are essential in increasing SSA's food base. This will result in a diversification of food crops which will ensure rural food security, dietary balance, intake of micronutrients and increased incomes to rural women who are often involved in the production and marketing of the vegetables.

Domestication of food plants generally involves identification of the plants in the wild, determination of their propagation methods, germplasm collection (accessions), cultivation of the plants away from the wild, mass selecting of adapted strains to local environments (farmers varieties, landraces), breeding for particular traits (genetic enhancement) and production of improved varieties and development of advanced agro-management techniques. For the domestication of African vegetables, some aspects of the first five steps have been realized by traditional farmers in rural communities.

- **Identification** As has been alluded to above, edible wild and weedy vegetable species have been identified and documented. Food values of some of the vegetables have been determined and results documented. Indigenous knowledge on the utilization of the vegetables and other socio-economic aspects are being documented in Kenya, Botswana, Zimbabwe, Senegal and Cameroon by International Plant Genetic Resources Institute (IPGRI) through a Dutch funded project. The knowledge gained should be validated and used to elucidate to formal scientists and policy makers the importance of African vegetables. This will definitely promote efforts and support for domesticating these vegetables.

- **Propagation** African vegetable species include annuals, roots tubers or may be gathered from trees. Vegetables can be propagated sexually or asexually and it is important to understand and know methods of propagating the various species. Already there are several vegetables which are semi-domesticated and are being sown and cultivated domestically in home or kitchen gardens or on fertile and moist areas on farms or along water ways. Most of these species are propagated through seed although in many cases their reproduction biology is not well known. Propagation methods of other species are even less known. To facilitate domestication, there is a need to know the propagation methods and reproductive biology of the various African vegetable species.

- **Germplasm Collection** This is an important step in the domestication process. Germplasm of the identified species needs to be collected from the various micro-environments and made available to farmers/growers. It involves the participation of local farmers and those people who have special knowledge about the species. The samples collected are then used in the cultivation phase of domestication. Already germplasm of some of the African vegetable species is with farmers for growing and conservation.

- **Cultivation** This is the step in the domestication process whereby identified species are cultivated in intentionally prepared plots. The species could be monocropped or

intercropped. This depends on existing local or indigenous knowledge and the nutritional and/or economic value of the species. African vegetables for local and urban markets are in some cases monocropped although during rainy seasons they are also gathered from wherever they are growing and then marketed. Site selection for cultivation, and cultivation practices of the vegetables, are the domain of the grower (usually women). These facts must be understood by formal scientists before any intervention is recommended.

- **Selection** This is a domestication step which is effected by farmers. Collected and cultivated species are mass selected for some important traits especially those for adaptation and nutritive qualities. The process takes several years and the end result is the development of landraces or farmers' varieties which are still heterogenous. This has been done for a few species of African vegetable crops. There is, therefore, a need for formal research to support the selection steps of domestication through;

  - germplasm collection,
  - evaluation and characterization,
  - selection of genotypes best adapted to various agro-ecological zones,
  - identification of ecological and cultural requirements of identified species,
  - seed production and distribution and
  - the preparation of production packages for each of the identified species.

- **Genetic enhancement** This involves the participation of formal plant breeders. The breeders make crosses to improve on specific traits such as increased biomass, uniformity in maturity (synchrony of flowering), resistance to abiotic and biotic stresses, nutritive and market qualities, etc. It involves the application of conventional breeding methods. The end result is the production of improved (and registered) varieties. There is hardly any released and registered variety of an African vegetable crop. There is need for formal plant breeders to improve particular traits of identified African vegetable species. Most of the species are low yielders, are prone to insect pests and diseases damage when brought into cultivation, do contain some anti-nutrients such as phenolics and oxalates and may not be adapted to some agro-ecologies where resettlement of rural people has taken place because of increased population (the resettled people normally move with seeds of their favourite crops and try to grow them in their new lands). The collaboration (participatory breeding) between formal plant breeders and farmers could accelerate the production of improved African vegetable varieties.

CONCLUSION

Many species of African vegetables have been identified and the role they play in nutrition and economy of rural communities has been recognized and appreciated by community development workers. There is, therefore, need for formal researchers, policy makers, and donors to support initiatives to accelerate domestication of the species. The initiatives could be in the areas of identification, propagation, germplasm collection, evaluation and characterization, cultivation, selection and production of improved varieties.

A REVIEW OF *CORCHORUS OLITORIUS* L. IN NIGERIA

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INTRODUCTION

Corchorus olitorius L.(2n = 14) or Jew's mallow, is widely cultivated as a leafy vegetable in Africa. In South East Asia there are many commercial varities of the species which are used as fibre crops. It is well adapted to a wide range of environmental conditions in both the wet and dry regions of Africa. For example, in Nigeria it is cultivated in all the ecological zones particularly in the South-western region (Nath and Denton, 1980). Outside Sub-Saharan Africa, it is important in Egypt and the Middle East as a leafy vegetable. Apart from *C. olitorius* there are other related *Corchorus* species which are cultivated as leafy vegetables in Africa. In Nigeria *C. tridens* and *C. capsularis* are cultivated by some farmers while *C. asplenifolius* and *C. trilocularis* are found as local vegetables in Zimbabwe and Kenya respectively.

Corchorus olitorius is classified as an indigenous African vegetable which is grown on its own or inter-cropped with staple food crops. It is easy to produce and matures in about 5-6 weeks after transplanting, making it attractive to most farmers for inclusion in their regular production programmes. In Nigeria, only the leaves are consumed, but the fruits are also eaten in some other parts of Africa and Asia. When made into soup the leaves are appreciated for their 'draw' property which aids the swallowing of solid foods made from staple food crops such as cassava and yams.

The cultivated types are highly variable. The rich genetic variation found in the many landraces has so far hardly been exploited, leaving ample room for development of improved varieties. This paper is a review of the production systems, utilization, indigenous knowledge, genetic and agronomic of *Corchorus olitorius* in Nigeria.

ECOLOGICAL REQUIREMENTS

Corchorus olitorius is produced over a wide range of climatic conditions extending from the Southern Rainforest Zone through the Southern Guinea Savanna to the Northern Sudan Savanna Zones of Nigeria. Within these agro-ecological zones, the crop can grow at altitudes of up to 1200m. It is poorly adapted to cold conditions and it will not perform well during the dry but cold harmattan period (Jan - March). The ideal conditions are a moist climate with a temperature range of 25°C- 32°C . The crop performs well in areas with rainfall of between 600mm and 2000mm per year. The soil for cultivation should be well drained sandy loam of good fertility. *Corchorus* does not grow well in poorly drained or clay soils.

DIVERSITY AND BREEDING

Many diverse plant types of *Corchorus olitorus* are found in Nigeria. The plants are variable in many vegetative and physiological characters such as leaf size, shape, colour; fruit size, seed yield, plant height, branching pattern, days to flowering and tolerance to diseases and pests. Generally speaking, farmers pay little attention to variation in plant characters when selecting cultivars for planting. When selections are made people look for characters considered useful for better yields, rapid revenue earnings and sometimes nutrition. The most commonly selected characters are large leaf size, deep green and glossy leaf colours, late flowering, rapid early growth and profuse branching.

In some areas certain leaf types are associated with the nutritionally desirable 'draw' property of the leaves and plants with specific leaf shapes are selected. The common practice, however, is to plant unselected and generally quite heterogenous local cultivars.
Those local cultivars are differentiated, based on leaf shapes and sizes, into four morphotypes which are known by different local names viz:

- **Oniyaya** - Deeply serrated leaves
- **Eti eku** - Leaf shape like the ear of a rat
- **Eti Ehoro** - Leaf like the ear of hare - oblong
- **Amugbada** - Lanceolate to ovate with shallow serrations.

Natural out-crossing resulting in intermediate types with different morphotypes are often found on farmers plots. This is probably as a result of farmers' practice to plant two or more morphotypes together on the same plot. *Corchorus olitorius* is self pollinating but varying levels of outcrossing (10-13%) have been reported (Grubben, 1977; Ephenuijsen, 1974; Data et al 1982).

In Nigeria, the genetic improvment programme on *Corchorus olitorius* is undertaken at NIHORT in Ibadan. The breeding programme is directed towards the production of improved and pure lines/varieties of the four major morphotypes. In this regard, locally available germplasm is collected, screened and classified based on days to flowering, branching habit, leaf shapes, leaf weight, total plant weight, seed yield, plant height, etc.

The hybridization programme is, however, hampered by regular flower drop after emasculation thereby making it difficult to transfer desirable genes from selected lines. Sytematic assessment of the extent of genetic variation within and between landraces has also been difficult. Germplasm of *C. olitorius* L. has also been collected in some other African countries (Attere et al, 1985, Hassam et al, 1983, and Pistrick, 1994). The number of improved lines which have been produced so far is not large and not distributed widely enough to cause a noticeable erosion of the rich local genetic resource. However, as farmers production methods become more sophisticated, the local varieties may gradually be replaced with improved varieties, some of which are over 80 - 90% better in yields.

Although, there is currently no serious danger of genetic erosion from introduced improved cultivars, collection and conservation of local germplasm is essential to create a large enough genetic base to be used for future improvement programmes. A national survey and studies on germplasm collections have shown that the centre of wide genetic diversity of this species is in the south-western zone of the country where the vegetable ranks among the top 5% of the most important leafy vegetables in terms of percentage of farming households that produce the crop as well as in the acreage under this crop.

PRODUCTION AND AGRO-TECHNIQUES

Production

Reliable production figures for this crop are not readily available. *C. olitorius* is produced in small patches of land, usually about 0.1-0.2 ha and often in a mixture with other food crops and vegetables. In terms of actual land allocation, food staple crops e.g. cassava, yam, occupy the largest area in the mixture (70 - 80%) followed by vegetables including *C. olitorius*. Most authors therefore find it easy to give production figures based on a group of commodities e.g. green vegetables. Such figures are however limited in value for estimates of individual crop production. About 30% of the annual production of farming households is eaten by the family while the remainder is sold, thereby contributing to the farm's income.

Planting period

Production of *C. olitorius* is principally rainfed and as such 80% of the annual production takes place during the rains. Dry season production is limited even though it attracts prices which are about 60 - 70% higher than those in the wet season. However, adequate irrigation water is required to ensure good yields. *C. olitorius* is susceptible to drought at different stages of growth and especially during the flowering stage (Ayodele & Fawusi, 1990). Higher vegetative yields are produced with increasing levels of water application. The crop attracts high market prices during the scarcity period of November to January whereas there is a glut period with corresponding low prices from June to October.

Cultural operations

Production of *Corchorus olitorius* is labour intensive. The major labour requirements are for land preparation, weeding, watering, harvesting and seed processing. Cultural operations are carried out by both men and women in the household. Land preparation and weeding are carried out by men, while harvesting, marketing and seed processing operations are for women. The type of land preparation required for planting depends on the soil types, location, and crop combination. All cultural operations are done manually, but a number of labour saving devices have been developed in NIHORT. In most traditional cropping systems, planting is done on the flat, mounds, or ridges or on raised beds. In peri-urban gardens, planting is mostly on raised beds, which have been found suitable for erosion control in water logged areas especially in lowland fadamas.

Cropping system

Production is dominantly by mixed cropping systems involving two or more crops. The companion crops are many and include staple food crops e.g cassava, yams, and various types of vegetables e.g tomato, lettuce, pepper, onion, etc. Among the most common crop mixtures are cassava/maize/*Celosia*/*Corchorus*; *Corchorus*/yam/maize, okro/*Corchorus*/pepper; *Corchorus*/*Amaranthus*/*Celosia*. The number of crops in the mixture varies but it is usually not more than five. In upland planting areas the combination always includes staple food crops but in low land plantings and in fadama and peri-urban gardens, only vegetables are combined (Denton et al 1988). The crops are selected without any consideration for the crops' disease and pest reactions and their nutrient demands. It is therefore not uncommon for farmers to plant tomato, *Celosia* and *Corchorus* together all of which are highly susceptible to nematode attack.

The inclusion of *C. olitorius* in combination with staple food crops is considered by most farmers to be a profitable means of early revenue generation while awaiting other crops to mature. Consequently, it is usually seeded first. *C. olitorius* is compatible for planting with many staple crops but it has a low competitive ability when combined with vegetables. However, experiments in NIHORT showed that the yield of *Corchorus olitorius* when planted with egusi-melon, *Citrullus lanatus*, did not differ significantly from the sole crop yield. Similarly, intercropping melon/okra/*Corchorus* did not reduce the vegetative yield of *Corchorus olitorius*.

Seeding and planting

Planting of *Corchorus olitorius* by farmers is usually by broadcasting. High seed rates are used. This method is wasteful, as many seedlings of poor quality are produced due to overcrowding. In addition field operations e.g. weeding and fertilizer application are made more difficult, laborious and expensive. Conventional tools such as hoes cannot be used in such plots without causing serious damage to the seedlings. However, in peri-urban gardens *C. olitorius* is cultivated by transplanting to meet the higher quality demanded by city dwellers. In transplanted crops, the spacing is 30cm between rows and 10cm between plants within rows.

Various research initiatives were carried out at NIHORT to address the constraints to efficient output from traditional cropping systems. Row planting and seeding at the rate at 5-8kg/ha. were

found optimum for good yield of *Corchorus* while harvesting by cutting produced higher vegetative yields than harvesting by uprooting.

The average vegetative yield of *C. olitorius* is 15-18 ton/ha but the edible leaf weight represents about 30-40% of the shoot weight. The yields are better when grown in soils with a high nutrient content and adequate water supply. Application of organic and inorganic fertilizers influence the vegetative yield of the crop significantly. Poultry manure applied at the rate of 20 ton/ha significantly increased the yield while optimum edible and marketable yields of the crop were obtained with the application of inorganic fertilizers at the rate of 75 kg N/ha, 20 kg P/ha and 40 kg K/ha. Information on genotype and environmental reactions of varieties is required for selection of suitable types for combination with other crops and profitable utilization of inputs.

Harvesting

Harvesting of *C. olitorius* can either be done by uprooting or by cutting. Initially uprooting is used to reduce plant population to create more optimal plant denstity. A total of 3-4 uprootings is carried out followed by cutting before the plants are left for seed production. There are varieties with different growth habits. Cultivars with rapid early growth may be suitable for harvesting just by uprooting while the later maturing cultivars are more suitable for harvesting by cutting.

SEED PRODUCTION

The annual seed requirement is produced by the farmers themselves. The local seed production system is laborious and wasteful. It involves beating the dry stems and branches with sticks, followed by winnowing. Plants are frequently left too long on the farm to dry, during which time many fruits are shattered before harvesting. Research investigations at NIHORT showed that seed quality is considerably affected at different fruit developmental stages. Fruit left to dry to a brown/black colour stage before harvesting resulted in a low percentage seed germination. But seed germination and seedling emergence were significantly increased when seeds which had been harvested from fruits which were yellow in colour were used (Oladiran, 1986).

Seed dormancy constitutes a major problem in establishing uniform plants of *Corchorus*. A general solution to the seed dormancy is par-boiling the seed. Placing seeds in simmering water for five seconds gave the best seed germination rate and uniform seedlings. Seed germination is also affected by seed sizes. Bigger seeds germinate faster and produce larger seedlings than small seeds. The position of fruits on the mother-plant also affected germination. Seeds extracted from the top and middle parts of branches are better than those from the base in terms of germination rate and quality of seedlings.

PEST AND DISEASES

The major pests of *Corchorus* in Nigeria are the leaf eating grasshopper, *Zonocerus variegatu,s* and rootknot nematode, *Meloidogyne* sp. Nematode infection can cause 100% plant loss as well as symptoms such as chlorosis, reduced leaf size and number and stunted growth. Nematode control was effected with less expensive and relatively easy cultural methods using fruit canning waste and pure poultry droppings. The crop has so far been free of major economic disease in Nigeria. Farmers hardly use chemicals for pest control but traditional methods involving the use of wood ash are at times adopted.

POST HARVEST HANDLING

C. olitorius is highly perishable. Post harvest losses of up to 60% can occur due to poor handling during harvesting and marketing. Traditionally, the shelf life can be extended for 1-2 days by maintaining moist and low temparature around the produce with baft cloth kept continously moist during the day, while at night, the plants are exposed to dew drops. The shelf life has also been extended for 6-10 days using locally designed evaporative cooling structures which have the effect

of lowering the temparature of the container environment through evaporation of water and increase in relative humidity. Various simple domestic evaporative coolant systems have been made (NSPRI 1990). The shelf life can also be extended by 2-3 days in perforated polythene pouches. Traditionally, a dehydration method is also adopted for the preservation of the leaves. Solar energy is used to dry the leaves after blanching and the leaves can then be kept for about 6 months without any serious damage to the quality.

NUTRITIONAL IMPORTANCE

The edible dark green leaves of *C. olitorius* have varying proportions of calcium, iron, carotene, vitamin C and protein required for good health. Application of inorganic fertilizer was found to improve the nutritional quality of the leaves. The ascorbic acid and mineral content (N, Ca, P) of the *Corchorus olitorius* leaves are higher when nitrogen fertilizer is used (Fawusi 1983). Varietal variations in nutritional qualities has not yet been studied. Mucilaginous substances produced when the green leaves are incorporated into soups aids the swallowing of solid food products, such as 'eba', which are prepared from staple food crops such as cassava, yams etc

Corchorus soup is cheap and easy to cook. It merely involves boiling the leaves in a pot until they become mucilaginous. Its easy preparation makes it very popular with the poor people. It is the most commonly prepared soup in many homes when most other vegetables are scarce and expensive.

Doctors in Nigeria have also found the 'draw' soup of *Corchorus* suitable for introducting babies to the consumption of solid foods, although information on the nutritional basis of this practice is not readily available

ECONOMIC VALUE

Sequential harvesting and marketing of *Corchorus olitorius* provides regular income to farm house holds during the cropping seasons. A substantial proportion (70%) of farmers harvests are marketed to provide cash for the family needs before the main staple food crops planted are mature and ready for sales. The market value of *Cochorus olitorus* is relatively lower in terms of unit cost than other indigenous leaf vegetables e.g. *Amaranthus, Celosia, Telfairia occidentalis, Vernonia* sp. However, the quantity marketed daily by individual market woman is usually higher. Both the leaves and seeds are good sources of income. Studies on the profitability of *Corchorus* seed production for sale indicated 75-85% returns above the production cost (NIHORT, 1986).

CONTRAINTS TO PRODUCTION

- High yielding improved varieties of *Corchorus olitorius* are not readily available to farmers. Consequently, most farmers are still planting the low-yielding traditional varieties.
- Genetic improvement is a slow and difficult process due to flower abscision after emasculation and pollination.
- Good quality seeds are not available to farmers for planting, family seeds are used from year to year.
- There are no guidelines for improved agro-techniques to obtain optimum yields
- Improved storage systems are lacking; post-harvest losses are significant.
- There are insufficient irrigation facilities to ensure year-round crop production.

EMPLOYMENT AND INCOME GENERATION

Employment and income generating capacity of *C. olitorius* will depend on;

- The development of simple labour saving devices for planting and crop maintenance.
- The availability of land and techniques to maintain the soil production capacity.
- The availability of improved agro-techniques to maintain production capacity.
- The availability of production inputs at affordable prices to farmers.
- Improved marketing and distribution channels for rapid marketing
- Good market prices.
- Training, especially for women, in production and utilization

CONTRIBUTION TO IMPROVED NUTRITION

- Development of nutritious products from *C. olitorius* through inclusion of e.g. protein rich condiments, thus improving its use as a weaning food.
- Developing alternative uses for the stems and branches of *C.olitorius* e.g. as animal feed.

DOMESTICATION OF *GNETUM Spp* BY VEGETATIVE PROPAGATION TECHNIQUES

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SUMMARY

The forests of Cameroon are fast disappearing under the pressures of timber exploitation, establishment of new farms, new roads, etc. The products that are found in these forests are disappearing along with them. This means that those local communities which depend on these products for their livelihood will suffer. *Gnetum africanum* and *G. buchholzianum* are two valuable vegetable species which may disappear as happened in Nigeria where they are rarely seen nowadays, contrary to the situation there only ten years ago.

To counteact this threat, an effort is being made in Cameroon to domesticate the two species concerned with the main aim of introducing them as a new crop for farmers. The technique being used to achieve this aim is vegetative propagation by rooting leafy vine cuttings.

After the success recorded in the domestication of the two *Gnetum* species in the propagation unit and the nursery in Kumba the next step is to get the cloned material to the farmers. However, the technique for establishing them on the farms has not yet been developed. Research efforts need to be made to achieve this in order to to save these natural resources from becoming extinct.

INTRODUCTION

As forests in West Africa, and Cameroon in particular, are currently shrinking in area, supplies of non-timber forest products are becoming increasingly scarce. This applies to *Gnetum africanum* and *Gnetum buchholzianum*, both leafy vegetables, and several species of fruits, mushrooms, wildlife and medicinal plants. Most of the conventional vegetables are only grown in the rainy season, so that they are often not available in the dry season. The vines of *Gnetum* species, with their edible leaves, are evergreen and produce throughout the year. The peak biomass production of this species has been observed to occur in the dry season. It has also been observed that after harvesting, the vines of both species usually sprout copiously. This happens mostly in the dry season when most other leafy vegetables are either dry or with seeds. The income generation ability of this vegetable is very high and it has been used as a traditional source of food. It is collected in the Congo Basin, south of the Central African Republic, Zaïre, Gabon (where it is known as 'okokok'), Cameroon, East Nigeria (where it is known as 'okassi' among the Igbo tribes) and in Equatorial Guinea. In these regions, the leaves form an important article of trade within and between countries. The trade in "eru", as it is known in anglophone Cameroon, has been highly developed and its volume is on the increase. In francophone Cameroon, *Gnetum* is called "okok".

This vegetable is peculiar in the sense that it can store fresh for about a week, but in most cases it is exported in dry form. When preparing it as a dish, the leaves are soaked in water to turn them to the fresh form. In this way, the leaves are currently being exported from Cameroon to Nigeria, where they are processed and dried and occasionally even re-exported to the black communities in Britain and America. In Cameroon, eru is an important non-timber product that is traded in by many people. The trade in eru is most pronounced between the forest and the savannah zones of the country where the vines do not thrive. Farmers in the South West Province of Cameroon in villages such as Ediki, Mbalange, Bombay, Barombi-

kang, etc. make a living from the sale of eru by making a monthly contribution of 1000 CFA when a trip is made to the forest on Friday to harvest ten bundles of eru which are sold on Saturday's market for at least 100 francs per bundle to get the amount of money needed for the contributions. This all depends on chance because there may be many other people wanting to harvest as well, otherwise, it is a sure means of making the weekly contribution. This can be more sure if the eru were domesticated and planted on individually owned farms or home gardens.

THE STATUS OF THE TWO *GNETUM* SPECIES IN CAMEROON

Although the value of this vegetable is high, it has not been domesticated anywhere. So far, the leaves are collected only from the wild. Some material is collected at the periphery of newly opened farms where the new growth does not look healthy because the vines here are exposed to direct sunlight, and this species needs shade. Seeds do not readily germinate in the nursery and if they do, it takes almost a year. On the whole, the biology of the two *Gnetum* species in Cameroon was not well known. It is only recently that some work has been started on the domestication of these species. Even now, many gaps still remain to be filled in our knowledge of their biology.

Taxonomy and Gender of *Gnetum* in Cameroon Forests

Various authors have stated that there are about thirty species of *Gnetum* of which only two occur on the continent of Africa. These are *Gnetum africanum* and *G. buchholzianum*. The two species can be distinguished by two main morphological characteristics; leaf shape and male and female reproductive parts. The male vines bear catkins which produce pollen which is transmitted to the female catkins which bear fruits. It was observed that the catkins of the cloned vines of *Gnetum africanum* had about the same diameter from the base to the top internodes, while those of *Gnetum buchholzianum* produce catkins with diameter decreasing from the base to the top internode. It was also observed that the leaves of *Gnetum africanum* from the nursery and propagation were thin, papery, light to pale green and ovate to oblong, while those of *Gnetum buchholzianum* were thick, deep to dark green and elliptic to oblong.

Habitat and habitat influence of *Gnetum* foliage

The two *Gnetum* species in Cameroon grow in three kinds of habitats i.e.

- in natural forests, where there is very little or no human influence
- at the periphery of the forests
- in the areas where the natural forest cover has been removed.

They thrive very well in natural forests, with the more luxuriant growth found in gaps created by fallen trees. They climb on middle and under-storey trees, although in certain areas the vines are found on the trunks of top storey trees with other climbers where they usually form thickets. Here both species produce dark green foliage and display the natural characteristics described above.

At the periphery of the forests, the vines grow mostly on shrubs and under-storey trees and are more exposed to light than the vines in the thick forests. The leaves produced here by the vines of the two species look different from those produced in the heart of the forests.

Vines that grow on abandoned farms or bush fallow produce smaller leaves which are pale green or even yellow in colour due to excessive sunlight since they are shade demanders. The initial growth in such situations is very good at the start, but soon deteriorates due to lack of shade and the right support plants.

These three conditions have misled local harvesters to think that there are three kinds of *Gnetum* in Cameroon. It is the habitat where *Gnetum* grows that influences the leaves produced. The two species will grow differently under any of these three conditions. It is further claimed by the harvesters and inferred by some buyers that those leaves harvested at the periphery of the forests store fresh for longer periods than those harvested from the heart of the forests because they are more used to light conditions. This contradicts my own observations in that the leaves from the forest are more mature and better developed than those from more exposed sites. Consequently, they have been found to stay fresh for longer periods than the leaves from the periphery.

Seasonality and growth of *Gnetum* vines

The two *Gnetum* species in the forests of Cameroon and the semi domesticates have been noticed to produce leaves throughout the year. They are therefore evergreen, unlike most leafy vegetables which shed their leaves and stop growth in the dry season. During the rainy season, entry into the forest is difficult, resulting in claims by traders that the vines do not produce a lot of leaves during the rainy season. The leaf production of both species is about the same in the dry season as it is in the rainy season. There is easier access to the forests during the dry season, which makes harvesters believe that *Gnetum* grows more in the dry season than it does in the rainy season. It is for this reason that the peak production of *Gnetum* leaves takes place in the dry season.

Reasons for domestication by vegetative techniques

Gnetum is so heavily harvested for domestic consumption, local and external markets, that the resource base is being threatened. In their natural habitat, the two *Gnetum* species use very tall trees as support. This makes them difficult to get to by harvesters. There are a few cases known of the death of some harvesters who have fallen from great heights in search of the leaves. Harvesting involves cutting and dragging down the vines, thereby destroying the vines which then cannot sprout to produce new shoots. The support plants or trees on which the vines grow are also cut down to gain access to the leaves. The forests are currently under pressure from timber exploitation, new road construction, establishment of new farms, etc. and are fast disappearing. It is consequently feared that these important forest products will disappear along with the trees, as it is the situation in neighbouring Nigeria.

The leaves of *Gnetum* are so income generating in Cameroon that the demands for them are becoming increasingly high, resulting in scarcity, such that the search for them has extended to the more remote parts of the country. In the forests of the western part of the forest zone such as the South West and Littoral Provinces, it is now difficult to get the vines which were abundant in the recent past. The trade in *Gnetum* offers employment to many Cameroonians and to people from importing countries.

Vegetative techniques

The seeds of the two *Gnetum* species do not germinate when sown under nursery conditions. However, wild seedlings were collected from the forest floor, indicating that these seeds can actually germinate, but they may need special pre-treatment. Germination problems remain to be solved but in the mean time rooted cuttings will have to be the method of propogation. Fruit production is not common so that insufficient seed would be available for widesrpraed propogation. It has been observed by this author that when the fruits are getting ripe in the forests birds, squirrels and other rodents eat them before they are completely ripe, which further reduces their availability.

From the different vegetative propagation techniques available, rooting leafy stem cuttings was chosen as the most appropriate, simpler and cheaper than other methods. This involves selection of vines with desirable leaves, preparing cuttings and inserting them into containers

with sawdust as the rooting medium. The vines were taken and brought to the propagation unit in the fresh state. Where the distance was great, vines were put in ice cold boxes in such a way that the leaves were not in direct contact with the ice.

Domestication of *Gnetum africanum* and *G. buchholzianum*

When studying tropical hardwoods for the IRA Station in Kumba it was discovered during the late 1970's that leaves of these two vine species were generating a lot of income to many families in the villages surrounding the Southern Bakundu Forest Reserve and other villages in Meme-Division.

This observation stimulated my interest and made me write research proposals to develop methods of studying these non-timber products with the aim of domesticating them and incorporating them into the farming systems of local growers. This was the start of the work on these two species of *Gnetum*.

In 1990 nodal leafy cuttings were taken and set to root in propagators with sawdust as the rooting medium The cuttings took about 35 days to root in non-mist propagators made with cheap local materials. They were potted and nursed in the nursery near the propagation unit. The cloned vines were planted along the edges of the nursery. They have grown to produce a lot of biomass, flower and fruits. More recently, much cheaper non-mist propagators have been constructed and are currently being used for rooting leafy vine cuttings.

RESULTS AND DISCUSSIONS

For the first time, this forest vegetable has been successfully grown outside the forest. The production of only fruits by some vines and only catkins by others, irrespective of the species, indicates that both *Gnetum* species are dioecious. It has been further observed that there are great differences between the leaves of the male and female vines of each of these species. The production of leaves on the vines of female *Gnetum africanum* is greater than those on the vines of the male.

In the case of *Gnetum buchholzianum*, leaf biomass production does not display noticeable differences. The cloned vines show that for high leaf biomass production, the vines of female *Gnetum africanum* and those of both male and female *Gnetum buchholzianum* should be selected for mass propagation work in the domestication process.

The vines growing in the nursery also show that the two *Gnetum* species need shade to grow well. The vines growing under shade produce healthy dark green leaves, while leaves of vines which grow towards the light tend to become yellow and have reduced leaf areas. The vines which sprout from underground vines away from shade produce vines that produce small yellow leaves which tend to curl over, perhaps in an attempt to reduce excessive water loss through transpiration. The growth performance of the vines under these light conditions makes it necessary to critically study the light requirements of the two *Gnetum* species before planting them out on the farmers' farms.

Vines growing on poles as supports produce more leaf biomass than those growing on live plants, although there are also differences among the vines on the live plants. This shows that the two *Gnetum* species are climbers that have association preferences. The vines of these species may not climb and produce high biomass on some tree species as support.

in order to propogate cuttings sawdust, simple propagators, watering and shade are required. Nurseries can be set up even in the village since the simple propagators are portable and can be carried on common vehicles. Cuttings need to be obtained from selected healthy vines whereby the leaf surface area of the cuttings is reduced to about 50 %.

It has been reported by Mialoundama (1984) that the two *Gnetum* species produce autotropic as well as plagiotropic shoots during vine growth. It was further stated that the autotroph shoot grows straight to great heights in search of light and does not produce leaves, while plagiotroph grow from the autotroph and produces leaves. This view does not agree with my own observations since I observed that autotrophs give rise to plagiotrophs and plagiotrophs also give rise to autotroph. This is of importance to growers who are interested in leaf production since one can start with either of these shoots to produce both.

It was also stated that *Gnetum* vines grow periodically in rhythms, whereas I believe that the vines of these species grow continuously, with a few flush periods and growth can terminate when the end of the plagiotroph produces catkins of flowers or fruits. However, the growth of these vines is generally slow.

RECOMMENDATIONS

After successful propagation in the nursery, the question is now raised how these vines can be grown on the farms or home gardens. Some preliminary trials were made to find out whether the vines can grow in direct sunlight. This involved planting some cloned vines in the shade of palm fronds with different degrees of shading and controls which were planted in direct sun light. The conditions here were close to those obtained in a farm situation. The results showed that the vines grown under shade did better than those in direct sun light. However, there were differences in growth rate and biomass production among the vines grown in the shade, with darker shades giving better results than those in light shade. This was not a full experiment. and the results cannot be reported scientifically. However, they indicate that *Gnetum* vines require shade for their establishment and growth on farms and in home gardens. The question now is, how much shade? It is recommended that further research be carried out to establish agronomic packages so that the two species can be grown on farmers' land.

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POTENTIALS AND CONSTRAINTS FOR INDIGENOUS VEGETABLES IN CAMEROON.

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SUMMARY

Cameroon has a wide range of indigenous vegetables including wild species many of which are only found in the lowland or highlands. Their true potential has never been exploited as no standardized practices exist for their production and because they are always grown together with other crops that compete for the same nutrients. When harvested, a large proportion of the crop gets lost because handling and marketing are poor. No post-harvest technologies exist or where they do, are either too complex or un-affordable for the producer. In addition, there is no pricing structure that is part of an overall agricultural policy and this discourages entrepreneurs who would like to produce these vegetables on a commercial basis. These constraints are examined and it is suggested that to attain the full potential of these indigenous vegetables, research is needed into the different stages of production, handling and distribution.

INTRODUCTION

Several criteria are used for classifying vegetables depending on their usefulness e.g. botanical criteria, optimum growing temperature, edible part of the plant used for food, salt tolerance and tolerance to soil infertility. According to the edible part criterion (which is of much interest to the consumer), vegetables can be divided into leafy vegetables, fruit vegetables, seed vegetables and root vegetables; grown respectively for their green leaves, fleshy fruit, dried seeds, and fleshy roots or lower stems.

INDIGENOUS VEGETABLES GROWN IN CAMEROON

Nutritional values and uses.

In the tropics in general and in Cameroon in particular, a wide range of both lowland and highland varieties of indigenous vegetables are grown. The ones that are consumed most nationwide are shown in table 1.

Table 1. Some popular indigenous vegetables in Cameroon.

Scientific name	Common Name
Solanum americanum	Black night shade
Amaranthus spp	Amaranth
Corchorus olitorius	Jew's mallow
Vernonia amygdalina	Bitter leaf
Solanum macrocarpon	African eggplant
Talinum triangulare	Water leaf
Hibiscus sabdariffa	Sorrel
Gnetum africanum	Eru

Fruit vegetables include okra (*Hibiscus caillei*) and garden egg (*Solanum aethiopicum*); an example of a seed vegetable is egousi (*Citrullus lanatus* and *Cucumeropsis manni*). From other plants for which the primary product is either roots and tubers or pulses, people may also

use their leaves as vegetables. Such crops include cassava (*Manihot esculenta*), taro (*Colocassia esculenta*), tannia (*Xanthosoma sagittifolum*) and cowpea (*Vigna unguiculata*).

The most important contribution of vegetables to diets is their supply of vitamins and minerals. But when the main food has a low protein content, protein supply from vegetables can be significant. Leafy vegetables are said to be particularly rich in carotene (pro-vitamin A), some B vitamins and vitamin C, minerals and proteins. It is believed that the consumption of leafy vegetables insures against detrimental effects (mainly anemia) caused by insufficient iron, folic acid or vitamin C. The minerals of importance in green leaves are iron, calcium and phosphorus. In diets where little or no use of milk and its products is made, leafy vegetables play a significant role in the supply of calcium. An average portion of 100 g of leaves provides 4 to 7 mg iron a day which is sufficient for a small child and a considerable contribution to the recommended intake of an adult.

Consumers in Cameroon mainly use fresh vegetables but dried vegetables are also used. They are eaten raw, boiled, stewed (with palm oil or fat), cooked into a sauce, or mixed with a staple and cooked together. They are mainly used as a supplement and scarcely eaten alone. Some of the vegetables are also used as medicines.

Production potential and constraints

Indigenous vegetables are rarely grown on their own and even when they are, it is usually on one or two beds only. The consequence of this is that they compete with other crops for nutrients and often grow in the shadow of much taller plants. Their true production potential therefore cannot be accurately evaluated.

During the dry season, these vegetables are grown in dry river beds or inland valleys together with other exotic types. These valleys are generally rich in nutrients, accumulated through the erosion of hillsides. Some researchers have concluded that these vegetables may therefore not need many additional inputs. However, since cultivation in the dry season is concentrated in these valleys and crops remove available nutrients, replacement of such nutrients will still be needed to maintain the high yields.

Traditional vegetables are not often grown on a large, commercial scale but are mainly used for home consumption and surpluses are sold in the local market. However, in recent years farming is being developed in urban and peri-urban areas where vegetables are becoming more important for the food supply of the urban population. In the cooler highland areas these traditional vegetables are less important than exotic species whereas in lowland areas indigenous vegetables dominate the market. No standard guidelines exist for their production. It has also been observed that their production is mainly a woman's enterprise.

Post Harvest and Market Problems.

Indigenous vegetables are perishable commodities, usually harvested with a very high moisture content. They continue life-sustaining activities even when they have already been separated from the parent plant. These activities, which are a function of the environment in which the vegetable is kept, leads to loss of quality through shrivelling. They may also be subject to bacterial and other microbial attack.

Improper harvesting, handling and transportation.

Most of the problems at this stage are due to improper harvesting such as just pulling fruits from a plant, thereby inflicting unnecessarily large wounds, both on the fruits and the plant. Because little or no research has been carried out on indigenous vegetables, "appropriate techniques" for harvesting and subsequent post-harvest operations are not available..

Incorrect handling is practiced widely. Very often, either through ignorance of the right procedure or in an effort to cut costs, producers use feed or fertilizer bags made of polypropylene to bring their vegetables to the market. These bags do not aid free circulation of air and the heat released by the respiring vegetables is thus not removed. The same applies to ethylene gas which will hasten the ripening of fruits. Where available, light trucks or cars are used for transportation to the markets. The lower bags are crushed by the weight of the produce above or by the elastic cord that is used for tying them to the vehicle. This results in injury to the vegetables with a consequent reduction in shelf life and market value.

Many of the vegetables also have their shelf life reduced considerably due to failure to reduce the field heat. Although there is a trend towards harvesting late in the afternoon or early in the morning, the vegetables are still held or transported during the day in ambient temperatures.

Most vegetables are consumed fresh and this poses a problem for keeping them after they have been harvested. Bitter leaf, cowpea leaves, eru and okra may be processed into dry forms and stored. Amaranth, a highly priced vegetable, is hardly processed into any form. A few enterprising individuals are experimenting on drying some varieties of this vegetable. Methods used include drying the harvested crop directly in the sun and partially boiling before drying. The dried product is then packaged into polythene bags. This is available in a wide range of thicknesses and grades, all of which are flexible, relatively tough, transparent and can be heat sealed. The resulting products have so far not been well received by housewives as the product is tough when cooked due to lignification of the tissue. Further research in this area is required. The possibility exists that optimum conditions can be determined through experimentation into drying amaranth.

Pests and diseases

Most indigenous vegetables are consumed directly. Pest and diseases affecting them after harvest are either not known or not fully understood. Further research is required to identify those pests and diseases and to find appropriate non-chemical and affordable control methods. We could expect that because of the high moisture content, keeping vegetables for a long period after harvest could expose them to some form of rot. Rodents are also responsible for, often considerable, losses of crops in storage.

Marketing arrangements

A large amount of vegetables produced in home gardens or on small plots is consumed by the farmer's family. The remainder is mainly sold at the farm gate directly to consumers or traders. Farmers may also opt to bring the produce to the markets themselves. The marketing system consists of the chain: producers - buyam sellams - consumers. This is different from other agricultural produce that may include supermarkets, hotels and restaurants.

When sales are conducted through local markets there is a problem in that no cooling facilities exist. Those that carry them to the market either harvest them late in the afternoon or do so early in the morning of the market day (Berinyuy, 1992). The vegetables are put in bags or baskets and are transported either by head or light truck.

Transport by vehicle exposes the vegetables to much risk from contamination and mechanical damage as the roads are generally poor. The vehicles transporting these commodities do so alongside passengers. The produce is secured elastic strings which adds to the mechanical damage and may also increase heat within the bag leading to further degradation of the quality of the vegetable. Because there is no proper system for storing the produce, most produce that is not sold the same day goes to waste.

Although the producer may transport the produce to the market, traders, locally called buyam sellams, may buy these at the entrance to the market. The price is usually determined by middlemen with the producer contributing only marginally to the price-setting process. Selling in the market is either by heaps, little bundles tied together or in little bags. The method of sale depends on the local custom.

Except for bitter leaf that is gradually gaining popularity in a dish called 'ndolé', there is a conspicuous absence of most of our indigenous vegetables on supermarket shelves and in major restaurants and hotels This could be due to a variety of factors such as;

- unreliability of supply
- lack of recipes
- lack of knowledge of preservation and
- absence of standard packaging.
- lack of quality standards for marketing vegetables.

It has been observed that because of increasing poverty, many consumers are becoming less demanding with regard to the quality of the vegetables they buy. This is also true for many other perishables that are sold in the Cameroonian market place. Many will prefer lower quality produce because they would pay less per unit and would therefore acquire a large enough quantity for the household.

Research

Very little research has been carried out on indigenous vegetables. In Cameroon, this has been limited mainly to cataloguing the types used. Many of the vegetables are grown with very little inputs and often on very marginal lands. They do not always produce well for long periods probably due lack of appropriate technological packages. A few types of vegetables are still harvested in the wild such as eru.

Improving production potential

Indigenous vegetable production can be improved through the development of technological packages that will enhance yields, disease tolerance and yet still retain the desired flavour that consumers prefer. Any agronomic research programme has to start by collecting cultivars of different localities followed by:

- Assessment of yield potential.
- Needs for fertilizers (quantity and quality).
- Assessment of water requirements, crop arrangements, cropping systems, harvesting techniques.

In the long run, breeding programmes can aim at improving characteristics such as high and early yields, high nutrient contents, resistance to diseases and pests and tolerance to other stress factors. This will have to be in relation to the taste and other quality preferences of the consumer.

Scientists should produce packages for extension staff and farmers so that they can facilitate the production of indigenous vegetables. Farmers will need to choose the site carefully, avoiding steep slopes and water-logged soils in favoour of soils that are rich in humus and those where eroded matter has accumulated. Because most vegetables are propagated by seed, seedbed preparation needs to be done with care and the seed stock chosen properly. Good husbandry practices should also be employed ensuring adequate water supply. Where this is

not possible, water should be made available through some form of irrigation. Because chemical fertilizers are often too expensive for many small producers, use of organic fertilizers and composts should be encouraged.

Diseases and pests should ideally be controlled by using resistant cultivars and crop rotation. Though the application of chemical insecticides is efficient, there is a risk of toxic residues for the consumer. It is important not to cultivate the same crop or related crops year after year on the same piece of land because of increased disease and pest incidence and exhaustion of the soil. It is also recommended to alternate shallow rooting and deep rooting crops.

Post harvest processing and storage

Domestication and increased production of indigenous vegetables are an attainable goal. But this will have to be matched with adequate development of post harvest systems for preserving the vegetables. Research will have to develop ways of reducing the undesirable high levels of spoilage and wastage.

Drying

Vegetables are bulky in nature and occupy much space when fresh. Moisture removal will have to be the first low cost primary processing that will be considered. This does not only improve the keeping quality of vegetables but also reduces the volume so that they can be stored easily in airtight containers. Solar energy is abundant in the sub-Saharan region and solar technology is already available for use with other agricultural commodities. This could easily be adapted to the processing of indigenous vegetables. Direct sun drying (without the use of a collector to enhance the insolation) is already being used by many producers for drying other commodities. Research will have to identify the optimum combinations of heat and time that will produce a product that is easy to keep and acceptable to the consumer.

Cooling

Eating fresh vegetables is by far the preferred method of consumption. Research will have to identify the low temperature tolerances of these vegetables and develop affordable systems for cooling and storing them. ?Structures are already in place in most of sub-Saharan Africa for cooling, transporting and storing fruits and exotic vegetables.? Through appropriate research these structures could be adapted for processing and storing of indigenous vegetables. Once such vegetables can be kept in a fresh condition, they are likely to become more attractive to super markets, hotels and restaurants.

Processing and Packaging

Processing is potentilly a method for increasing production. Varieties that are very bitter will have to be processed to remove some of the bitterness on order to make them more attractive to the consumer. Processing methods that are used with fruits and some exotic vegetables, such as calcium chloride dips, blanching, etc. maybe adapted for the processing of these vegetables. Packaging which will retain product quality and still be attractive to the buyer will need to be developed. There is also the need to develop and promote novel products based on indigenous vegetables.

Institutional support

Organization of a proper marketing channel is important to encourage the production of traditional vegetables and to assure an income for the producers. This could possibly be through farmers' cooperatives. There are advantages and disadvantages for creating these cooperatives but each option will have to be evaluated in its own right. Capital will have to be

made available for entrepreneurs who want to take up processing and promotion of these vegetables. There is also a need for a clearly defined pricing policy that is consistent with an overall agricultural policy. This must include a clear definition of the role of the public sector, vis-à-vis the private sector in the marketing system. The defined marketing channel could also act as a channel for disseminating developed technologies and maintaining quality standards.

CONCLUSION

Cameroon has a large choice of indigenous vegetables, including species that are currently harvested from the wild. These vegetables could play a very important role in the food security of the country. However,their potential has not been adequately exploited.

We have tried to highlight some of the problems that need to be addressed to further enhance indigenous vegetables in Cameroon. Their renewed popularity could then contribute to the producer's income thereby alleviating poverty. Such efforts are also necessary to make these indigenous resources more attractive to consumers. Much research is needed to establish standard agronomic recommendations for producing these vegetables, develop packaging and identify markets for them. It is only when producers have such technological packages available that they can consider indigenous vegetables a serious market alternative.

EXTENSION OF AFRICAN WINGED BEAN IN ZAIRE

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About 25 years ago, during a meeting of the Department of Biology, part of the University of Kinshasa, we asked ourselves a question: "How can we, biologists, botanists and zoologists, struggle against hunger and lack of proteins as we find among the population around our campus?" We could not answer the question but decided that each professor would initiate some research to create new and inexpensive sources of animal and vegetable proteins.

Unfortunately we began to dream of game cropping, domestication of African buffalo and antelopes. With a young colleague we visited a farm in Naivasha and the Galana Ranch in Kenya. But it was a wrong direction for us: there are too many poachers near Kinshasa! Nevertheless, we continued our efforts to domesticate mini-livestock: giant rats, giant African snails, frogs and earth worms (the latter for animal feeding).

Around 1975, we found literature on and got seeds of winged bean *(Psophocarpus tetragonolobus)*, a leguminous vegetable, traditionally grown in Asia and Papua-New Guniea whose leaves, pods, sprouts, beans and tubers are eaten and were found to be rich in protein. I must explain that at this time, we began at our department of Biology a program of "Environment Management", where I was (and still am) in charge of lecturing on "Ecodevelopment" i.e. how to promote a sustainable development using the potential of one's own environment.

I was therefore very pleased to learn from a colleague botanist, Mr Luk Pauwels, about the existence and presence in Kinshasa and all over Zaire and central Africa, from Cameroon to Angola, to Tanzania and Mauritius, of the cousin of the winged bean from Asia: *Psophocarpus scandens*. To avoid confusion we called it "African winged bean" and the other one "Asian winged bean". In Kinshasa, the African winged bean is mainly known as **'Kikalakasa'** a traditional vegetable whose leaves, pods, sprouts, beans and tubers are edible. The leaves were known by local people to have galactogenic properties i.e. they encourage milk production in nursing mothers. Unfortunately, this vegetable was more and more neglected. In some tribes, those who eat kikalakasa were regarded as extremely poor people , 'miserables'. *Psophocarpus scandens* is traditionally eaten in at least six of the eleven regions of Zaire but nowhere is it cultivated. However, it is used as a cover crop in rubber trees and palm-tree plantations and sown as such. In and around Kinshasa we found wild kikalakasa in 120 different locations. These were generally humid places, near rivers and marshes. Up till now, we have not found any tuber of African winged bean.... except in the literature! The plant is climbing and perennial.

Around 1980, with Professor Onyembe and other colleagues, we published the chemical composition of kikalakasa. The leaves, which are traditionally eaten as vegetable, contain 7.1% protein when fresh and 39% when dried, 2.2% lipids when fresh and 12,1% when dried . Further studies confirmed the high nutirtional value of this neglected vegetable. We now came to realise that kikalakasa was the kind of vegetable we were looking for. We made inquires in various directions. We found only two persons who were actively cultivating the African winged bean. We found only one lady, selling kikalakasa secretly to private clients. We found that, according to their main tribal origin, between 3 and 11% of the population of different urban districts know something about kikalakasa or had once eaten it in the village. We found that, as a general rule, those who had eaten it when young in the village, kept a good impression of it as far as the taste is concerned. We also found the existence of various recipes from different regions.

We decided to promote this plant from a wild vegetable, used only by poor people, to a respectable vegetable, known for its richness in proteins. We wanted it to be cultivated in all kitchen gardens of Kinshasa and elsewhere. We began to study its specific cultivation techniques. For instance, it was found that the seeds are very hard. This contributes to keeping their viability for many years but necessitates scarification before planting. Then we made an effort to wipe out social preconceptions about kikalakasa, using the mass media, particularly the radio, to let people know that the university had found out that kikalakasa was one of the best vegetables for Zaire. It is very rich in proteins and galactogen and is easy to cultivate in kitchen gardens. Fortunately, people believed in what was said on the radio and they also had faith in our university and afterwards the issue of social unacceptability was no longer a problem!

In the beginning of 1988, with help from Unicef, we started an NGO called: **Kikalakasa Vulgarisation Project**. But, as we were conscious of the fact that lack of protein cannot be solved with only one kind of vegetable, we started a large inquiry into kitchen gardens and small animal husbandry in 2,526 housing plots of Kinshasa. This survey has shown the presence of 273 plant species out of which 100 species (36%) are used for food.

We concluded that "These domestic plant resources constitute a part of an urban ecosystem that can be utilised for the well being of man".

People could express to us their needs, experiences and failures as far as kitchen-garden agriculture was concerned. This gave us the idea to begin in 1989 with a new NGO called: **Jardins et Élevages de Parcelle, JEEP** (Kitchen-Gardens and Mini-Livestock Project, in English). Apart from kikalakasa, JEEP also promotes the culture of other kinds of vegetables, mainly traditional ones such as *Amaranthus, Basella, Colocasia, Hibiscus, Ipomoea, Manihot*, etc. Our extension team of 30 persons, all part-time, help people to improve the agricultural techniques (soil fertilization, etc.) of producing these vegetables. Today, more than 10,000 families in Kinshasa cultivate kikalakasa in their kitchen-gardens and maybe another thousand or so in other towns of Zaire.

A young Zairean colleague, a nutritional biochemist, who worked with us from the beginning, is working in villages of Kwango-Kwilu district in the same way as JEEP does in Kinshasa, especially for kikalakasa. He created an NGO **called Projet Revalorisation des Aliments Traditionnels du Kwango-Kwilu (PRAT)**. He drew up an inventory of traditional foods in 22 villages between Kikwit and Kenge and found 108 different species of vegetables, 77 species of mushrooms, 22 species of tubers and 28 of fruits, nuts and seeds. In 1992 he published the chemical composition of all those species. As kikalakasa only ranks as no. 9 in protein richness, we plan to study the other eight richer species. To date, we have begun observations on *Albizia adiantifolia*, the no. 1. We hope to find money for a study on the other eight species.

I shall finish by speaking once more about kikalakasa and mushroom cultivation before I draw conclusions and make suggestions.

On kikalakasa, we continue our work of promotion, helped mainly by the European Community. First through extension work from street to street and house to house, with medical and nutritional centres, NGOs, churches and schools. And afterwards through the media (radio, T.V and newspapers), T-shirts, umbrellas, wax, stickers, tracts, brochures, calender and songs. We keep contact with 13 towns of Zaire where the message of Kikalakasa has arrived spontaneously. Research projects continue on kakalakasa, mainly through students undertaking undergraduate and graduate diplomas. For instance, it has been established that the leaves are richer in proteins and in lipids before fructification tather than during and afterwards. We also learned that an association with sweet potatoes improves some aspects of kikalakasa culture. With regard to processing: the

leaves can be dried, made into a flour and mixed with other flours; seeds can be roasted and a good flour, very rich in lipids and proteins (33%) can be obtained.

There has been a spontaneous development of a marketing system: we found 83 ladies selling kikalakasa in small markets in Kinshasa. kikalakasa had a competitive problem with Fumbwa *(Gnetum africanum)*;. Their tastes are quite similar but kikalakasa is cheaper. Ladies selling Fumbwa have lost money and counter-attacked by saying that kikalakasa is responsible for some illnesses.

Finally, may I ask the participants to let me know if *Psophocarspus scandens* produces tubers in their countries? If the answer is yes, where can I get seeds of those varieties?

CONCLUSIONS AND FINAL SUGGESTIONS

Psophocarpus scandens is more and more recognized and adopted in Zaire as both a traditional and a modern vegetable, very rich in proteins and an effective galactogene. It is cultivated and consumed in more than 10.000 housing plots of Kinshasa. It needs some more research and extension work.

As *Psophocarpus scandens* is also present in other African countries from Cameroon to Angola and to Tanzania, we suggest that a vast regional research-programme ahould be promoted, beginning in Zaire and then extending first to Congo, Gabon and Angola, later to Tanzania, Cameroon , etc., and finally including all African countries where (other) local species of *Psophocarpus* are eaten.

To begin immediately, may I ask to each participant to fill at home in conjunction with botanists and agronomists, the questionnaire on *Psophocarpus* and to send it to us in Zaire.

Long life to this new African Winged Bean Network!

QUESTIONNAIRE ON LOCAL PSOPHOCARPUS SPECIES
(NETWORK OF INFORMATION ON PSOPHOCARPUS)

1. Name
2. Function
3. Address

4. Country concerned
5. Name of local *Psophocarpus* present in the country (e.g. *scandens, palustris* etc.)

6. For each species: What parts are (or were) eaten

7. Are you aware of tubers on these crops, are these used in any way?

8. Other useful information:

Please, send back this questionnaire to J. Paulus, JEEP, through one of these 3 ways:

- JEEP, BP 114, UNIKIN, KINSHASA 11, ZAIRE.
- J. PAULUS - JEEP, c/o Missieprokuur, chaussée de Haacht, 8, 1210 BRUXELLES, BELGIQUE
- (If there is a Belgian Embassy in your country:) Prof. J. PAULUS (UNIKIN - JEEP) c/o Ambassade du Belgique à Kinshasa (service de la co-opération) (without stamp if posted at the embassy).

THE TRANSFORMATION OF LEAFY VEGETABLE CROPPING SYSTEMS ALONG THE HUMID FOREST MARGINS OF CAMEROON

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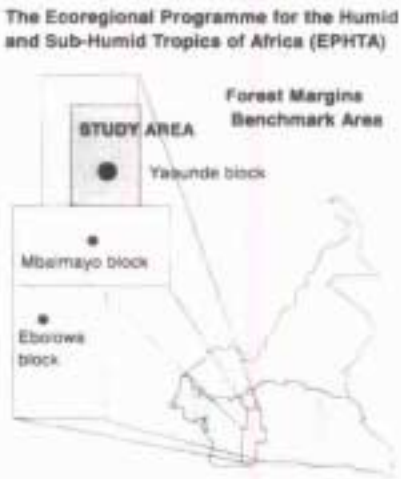
Michel Ndumbe
Institut de Recherche Agricole Pour le Devellopement

INTRODUCTION

Over the last 30 years West and Central Africa have undergone an important demographic transformation with rural populations flooding into urban centers across the region. In response to growing urban demands, those remaining in rural areas are adapting their agricultural and marketing systems to take advantage of expanding commercial opportunities for agricultural products. Adjustments have been especially pronounced in regions adjacent to urban centers.

The study of spatial rural development patterns has a long history in economics. If transportation costs are low and the efficiency is high in rural areas, regional comparative advantages in production, due to differences in soil fertility, climate, etc. are likely to outweigh those near urban centers. However, marketing advantages are much greater for highly perishable commodities such as leafy vegetables, especially with poorly developed transportation systems. This study examines the production and marketing of leafy green vegetables based on a survey of horticultural production and marketing within certain cells of the Yaounde block of IITA's forest margins benchmark (Figure 1).



OBJECTIVES OF THE STUDY

The objectives of the study were to better understand the processes and structure underlying the rapid adoption of monocrop systems of leafy vegetables. Another important objective was to determine the relative commercial importance of the various leafy vegetable crops so that future horticultural research may be appropriately targeted. This is particularly important for indigenous leafy vegetables, given their relative neglect in agricultural research to date.

The study area was confined to eight 10 minute by 10 minute quadrats shown as the shaded area of the Yaounde block in Figure 1. The selection of these quadrats was based on their proximity to Yaounde and their communication infrastructure.
Figure 1. Location of Horticultural Study

Farm Size

In general the area cultivated on an annual basis is small, reflecting the difficulty of clearing and cultivating using only hand tools and manual labor. The mean annual area cropped per household is estimated at 0.79 ha. This area is slightly larger than the 0.71 ha estimate obtained by a survey of cocoa growing households in the Littoral, Center and South Provinces.

It is also larger than the findings of Tshibaka (1989) for the humid forest zone of Zaire (0.67 ha) but smaller than for the Zairian basin (0.88 ha). If we further assume that the mean household in the survey operated on a 1 year cropping, four year fallow rotation, then the mean area devoted to annual crop production (including fallow fields) would be 3.95 hectares.

Numerous types of fields are distinguishable in the farming system of the humid forest zone of Cameroon. Fifteen principal types in the sample area were identified, differentiated either by crop association, field location or temporally (Figure 2). Of these, the groundnut-based, mixed food crop field (*afub owondo*), cocoa plantations and forest (*esep*) fields have been fixtures in the farming systems of southern Cameroon for many years. Field types that have more recently appeared are monoculture fields (mainly for horticultural production), simplified mixed food crop fields without groundnuts, home gardens, inland valley fields and dry season fields. Overall the mean number of different field types per household was slightly over four.

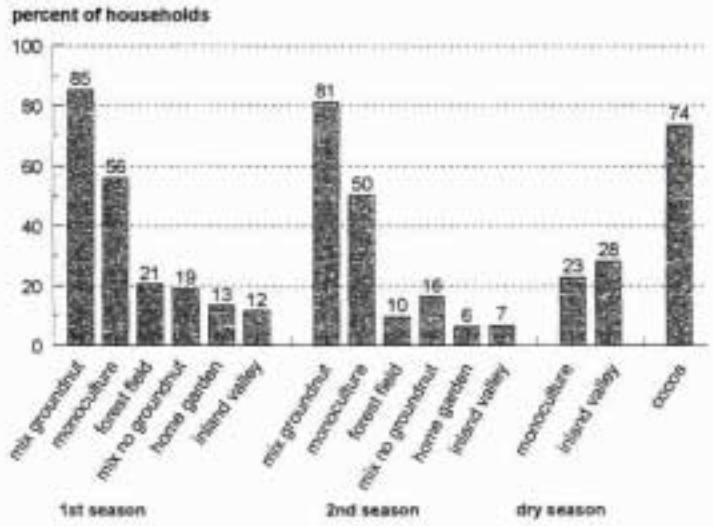


Figure 2. Field Types

The most important crops are groundnuts and cassava. Groundnut serves as the main source of dietary protein with only between 10 to 12 percent of the total production sold. The relatively small size of these fields and their mixed nature limits groundnut production. Household survey data from the Ministry of Agriculture place the estimated mean annual production per household in the Lekie and Mefou Divisions at only 90 kilograms.

Cassava, the other major component of the system, is the main starchy food in a diet that also includes significant amounts of plantains, cocoyams and yams. In general, the preferred consumption form of cassava is boiled, thus farmers grow mostly sweet, low HCN, varieties that do not require cyanide processing. The estimated cassava yield from the mixed groundnut cropping system is calculated at 5.2 tons. Besides groundnuts and cassava, other important annual crops included in this cropping system are cocoyams, maize, yams and indigenous leafy vegetables.

Horticultural Production Management and Marketing

We now turn to the role of horticultural production and marketing within the farming systems briefly described above. Horticultural products were classified into four major groups: leafy vegetables, other vegetables, spices and condiments, and fruits. The survey found a most remarkable diversity of products produced for market with on average 18 different species marketed per household.

Leafy vegetables were the most commonly marketed group of horticultural crops, with eight different types marketed by a majority of the households. It is among this class of horticultural crops that we find indigenous species including *Solanum americanum, Solanum macrocarpum, Solanum aethiopicum, Corchorus olitorius, Amaranthus viridis, Gnetum africanum, Vernonia amygdalina, Talinum triangulare, Cucumeropsis edulis* and *Cucumis melo*. The widespread production of leafy vegetables and their importance in rural diets is a reassuring source of *in situ* genetic conservation. No evidence of the replacement of indigenous species of leafy vegetables by exotic species of *Brassica*, as documented elsewhere in east and southern Africa (Lewis, 1996), was discovered by our study.

Beyond their role as a cash crop, leafy vegetables play a particularly important role in meeting household nutritional needs. For most rural households they serve as the main accompaniment to the daily starch and are the chief supply of critical micronutrients such as iron, vitamin A and vitamin C. Information on the frequency and type of leafy vegetables consumed was gathered to quantify their nutritional importance. In nearly two-thirds of the households, leafy vegetables were prepared with a frequency of between 4 and 7 times weekly (Table 1).

Table 1. Frequency of Preparation of Leafy vegetables Per Week (n=200).

Weekly preparation	Percentage of households
1 x	6.0
2 x	6.5
3 x	23
4 x	25
5 x	20
6 x	18
7 x	1.5

In ranking order, cassava leaves, *Solanum spp., Corchorus spp.* okra leaves, *Gnetum spp* and Amaranth were most commonly consumed. Most of these leafy vegetables (*Solanum americanum, Corchorus, Amaranthus, Vernonia*, and *Cucumis*) are prepared with a groundnut

Table 2 Consumption Preferences among Rural Household for Leafy Vegetables (n=200).

Crop	**Most consumed**	**2nd most consumed**	**3rd most consumed**	**Total**
Cassava leaves	75.65	11.40	5.76	92.81
Zom (*Solanum* spp.)	9.84	46.11	19.89	75.84
Tege (*Corchorus olitorius)*	7.77	23.31	34.55	65.55
Okra leaves	2.59	8.81	8.90	20.30
Okok (*Gnetum africanum)*	1.55	2.59	10.99	15.13
Folon (*Amaranthus viridis)*	1.55	3.11	6.81	11.47
Cocoyam leaves	0.00	1.55	4.71	6.27
Melon leaves (*Cucumis* spp)	0.00	0.52	3.66	4.18
Etoe	0.00	0.52	1.57	2.09
Kele kelen (*Hibiscus afer)*	0.52	0.52	0.52	1.56

base and possibly some dried fish (*bifaka*). Others are prepared with palm oil (cassava leaves and *Gnetum africanum*).

Additionally, many species of leafy greens also find medicinal use. For instance, a drink prepared from *Hibiscus afer* is used to treat anemia, while *Vernonia amygdalina* is used in treating gastritis. The importance of *Gnetum africanum* as a vegetable in the diet and as a source of revenue (it is sold by over one-third of the households) should be noted. This wild species grows as a wild woody vine in the natural fallows following cultivation. Efforts being pursued at IITA, ICRAF and elsewhere to replace natural fallow succession with planted 'improved' fallows of nitrogen fixers must accommodate the important multi-purpose roles played by indigenous fallow species such as *Gnetum africanum* as food, medicine and cash crop in rural households.

Commercial Importance

Marketing frequency does not necessarily indicate the economic importance of a crop as this measure neglects its relative household importance. Households were asked to rank the first and second most important horticultural crops. Overall, vegetable crops were most frequently cited in terms of commercial importance, accounting for 44 percent of the 1st and 2nd rankings (tomatoes were most important). After vegetable crops, came fruits cited by 31 percent (dessert bananas were most important within group), leafy vegetables by 17 percent and condiments at 8 percent. Thirty-six percent of the 172 households who ranked vegetable crops as first or second, cited horticultural revenues as either the "most important" or an "important" source of agricultural revenues, compared to 26 percent for fruits, 25 percent for leafy vegetables, and 16 percent for condiments.

Constraints to growing leafy vegetables

Farmers were asked to list the problems which they encountered in the production of leafy vegetables. The most frequently cited problem was that of insect and nematode damage. If insects, rodents, birds and disease pathogens are lumped together as pests then 70 percent of the households could be classified as having pest problems (Figure 3).

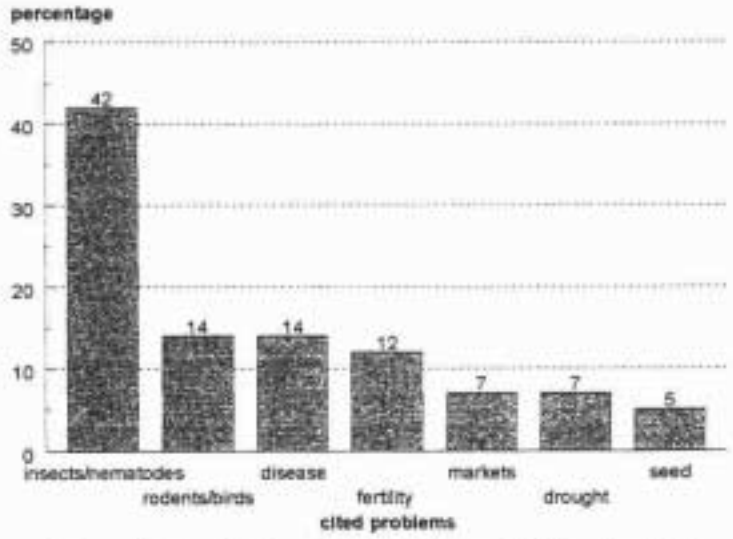


Figure 3. Leafy Vegetable Problems Cited by Farmers

Leafy vegetables were still predominantly grown in association with other crops in a majority of the cases. The most common field type for growing the three most commercially important leafy vegetables (*Solanum, Corchorus, and Amaranthus*) is the mixed groundnut field. They are traditionally planted in one of two ways; either randomly broadcast in the field or planted into concentrated ash piles left in the field where biomass has been accumulated and burned.

The production of leafy vegetables appears to be trending towards monocropping, particularly for *Solanum, Corchorus, and Amaranthus;* over one-third of the households were producing these in monocrop systems. Households adopting monoculture systems for leafy vegetable production tend to have more male involvement in production decisions whereas women are more involved in traditional cropping systems.

Farm inputs

Use of purchased inputs was found to be common in the production of exotic vegetables but less common in the local leafy vegetables. Inorganic fertilizers and pesticides were commonly used in the production of tomatoes, green peppers and okra. More than 50 percent of the households with monoculture production systems for *Solanum, Corchorus* and *Amaranthus* used inorganic fertilizers and over 75 percent applied chemical pesticides. The high use of pesticides and fertilizers raises issues of health and environmental risks. Many of the new adopters of intensive monocrop systems are using these chemical products with little or no information on their safe use and handling. Alternative strategies such as integrated pest management should be explored as ways of reducing the economic costs and environmental hazards posed by excessive chemical use. The use of fertilizers, purchased seeds and pesticides is linked to the type of cropping system and the proximity of the sample area to the urban center of Yaounde where at least eight certified agricultural supply stores and countless unlicensed sellers compete.

Market Channels for Leafy Vegetables

Women producers would most typically sell their leafy vegetables and other horticultural products either to market women in Yaounde, locally known as *"les bayam-sellams"* or directly to consumers. No household reported selling directly to wholesalers. Households with monocrop leafy vegetable production systems were less likely to sell directly to consumers, tending instead to sell exclusively to the *bayam-sellams*. Compared to other categories of crops, leafy vegetables were more frequently sold directly to consumers.

The major market destination for all crops was Yaounde but particularly so for leafy vegetables which had the highest reported frequency among all crop categories. For households living relatively close to Yaounde (<20 km) with good market access, leafy vegetables are harvested very early in the morning, then crammed into the ubiquitous, overloaded bush taxi, for arrival between 6am and 8am in the market. Upon arrival the bush taxi is descended upon by the *bayam sellams*, fighting to lay claim to the various produce on-board. The producer may or may not choose to sell to the *bayam sellams*, she may instead choose sell direct to consumers in the market. In outlying areas (>20 km) leafy vegetables are more commonly harvested in the afternoon, brought into Yaounde at dusk and sold to the *bayam sellams*. The low frequency of sales in district and local markets probably indicates that most households are self-sufficient in these crops. Because of their rapidly perishable nature leafy vegetables are rarely sold along the roadside.

With regard to market behaviour, in general market efficiency is equated with competition and low marketing margins. Price observations, weights, measures and interviews with *bayam-sellams* were conducted in the early morning in the Yaounde food market as village women were arriving with their leafy vegetables. The market for leafy vegetables has established several norms. The standard retail unit of sale is a bundle of leafy greens. The quantity per bundle is in general the amount necessary to feed a family of four to five persons. Prices tend to be stable around focal points and adjust in round number increments e.g. 100 FCFA per bundle, 150 FCFA per bundle, 200 FCFA, etc. There is a lack of knowledge with regard to other local and regional markets that could cause the market to be performing less than perfectly. The estimated marketing margins in Yaounde range from 18 to 37 percent. These

levels are certainly not excessive given the high level of marketing risk assumed by these *bayam sellams*.

SUMMARY AND CONCLUSIONS

Indigenous leafy vegetables are assuming an increasingly important commercial role especially for farming households living near urban centres. At the same time they remain one of the mainstays of rural diets in the humid forest margins of West and Central Africa. The inattention paid by national and international agricultural research institutions to the agronomic, genetic conservation, and crop management problems posed by these key crops is anathema to better nutritional status and reduced disease incidence among rural women and children. Their production is still the result of largely traditional methods although a trend towards intensive monocrop horticultural production is evident.

63% of rural households consume leafy vegetables on average at least 4 times weekly while 20 % of households consume them at least 6 times weekly

Households with monocrop horticultural production systems were much more likely to use pesticides and fertilizers than households with traditional systems. Monocropping systems are mainly being adopted by the younger male portion of the rural population in response to income needs. There was a significantly lower probability of adopting these systems if the producer was a women who is normally responsible for growing vegetables for the household' needs.

The near non-existence to date of a focused research effort on leafy vegetables, in combination with a well defined development domain, suggests that the returns to even a small research investment on leafy vegetable production would likely be high. Potential resource management research needs to examine the issue of pests and diseases which were the most commonly cited problems by farmers.

The genetic conservation and improvement of African leafy vegetables (other than the important *in situ* efforts by farmers) is not currently being addressed. Ethnobotanical studies can provide a better understanding of the uses and values of leafy vegetables by rural people and can inform the policy making process and the design of policies so as to maintain these *in situ* conservation efforts. There is also a need for international research institutions such as IITA to establish formal germplasm collections to back up the efforts of farmers.

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THE PLACE OF INDIGENOUS VEGETABLES IN THE FARMING SYSTEMS OF CAMEROON

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INTRODUCTION

Indigenous vegetable species are those that are native to Cameroon but may be found in other tropical African countries as well. There is an abundance of these vegetables found throughout the country, some of which are cultivated and others are harvested straight from the wild. It is worth mentioning that in this text, a distinction is made between conventional or traditional vegetables grown in Cameroon and indigenous ones. In 1990 Stevels carried out an inventory of traditional species of vegetables in Cameroon and identified 67 species (table 1). However, this list is far from exhaustive. Indigenous vegetables have a very important place in both the diets of the various ethnic groups and the farming systems of the different farming communities in Cameroon.

In Cameroon as elsewhere in sub-Saharan Africa where people cannot always afford milk and meat, indigenous vegetables, especially the leafy types, form a very important source of minerals and vitamins such as calcium, phosphorus, iron, thiamine, riboflavin, nicotinic acid and vitamins A and C. A further note was made of the high fibre content which helps reduce absorption of toxic substances in the intestines, thus reducing problems of constipation, which is frequent in Africa.

The actual role or importance of the different species in the farming systems differ from one agro-ecological zone to the other. Consequently the importance of any species in an area depends on the eating habits of the local people. The eating habits refers to whether it is eaten as a main dish (served with the main starchy staple of the area), side dish, eaten alone or added to sauces with other vegetables. Thus, their importance and prevalence in the farming system of any zone depends on the value (as described above) and the frequency of use among the indigenous populations and on its popularity at the national level, while popularity is reflected by their availability in major markets all year round. This paper discusses the place of indigenous vegetables associated with the different farming systems across the five main agro-ecologocal zones in Cameroon.

FARMING SYSTEMS OF CAMEROON AND THEIR ASSOCIATED CROPS

Vegetables are mostly grown in systems in conjunction with a wide range of crops, the greatest variety and the largest number being found on compound farms and in adjacent fields. An increase is noted in the use of hygromorphic soils for off-season cultivation of vegetables. However, for the purpose of this paper, farming systems will be reduced to the predominant cropping systems in each of the five agroecological zones and the predominant indigenous vegetable species found in them. The characteristics of the five agro-ecological zones in Cameroon are given in table 1. There are two major cropping systems in Cameroon; the rain forest areas (zones 1 and 2) in which tree crops dominate and rootcrops form the basis of the cropping system and the savanna areas (zones 3,4, and 5) where cereals and grain legumes dominate.

Table 1 Important Indigenous Species of Agro-ecolgical Zones

Agro-ecological Zone	Farming System	Predominant Indigenous Vegetable Species
Semi-humid Forest	I. Cassava - based II Cocoyam - based III Plantain fields	*Amaranthus cruentus, Abelmoschus caillei, Xanthosoma sagittifolium, Vernonia spp, Citrullus lanatus, Cucumeropsis mannii, Cucumis melo, Cucurbita moschata, Cucurbita maxima, Manihot esculenta* leaves, *Gnetum spp.*
Humid Forest Zone	I. Cocoyam - based II. Cassava - based	*Amaranthus spp, Colocasia esculenta* leaves, *Vernonia spp, Citrullus lanatus, Cucumeropsis mannii, Cucurbita maxima, Telfairia occidentalis, Manihot esculenta* leaves, *Gnetum spp, Abelmoschus caillei, Abelmoschus esculenta, Talinum triangulare,* Black night shade, *Solanum macrocarpon, Corchorus olitorius.*
Highland Savanna Zone	I. Maize - based II. Cocoyam - based	*Amaranthus* spp, *Xanthosoma* leaves, *Vernonia* spp, *Cucumeropsis mannii, Cucurbita maxima, Cucurbita moschata, Telfairia occidentalis, Manihot esculenta* leaves, *Vigna unguiculata* leaves, *Abelmoschus caillei, Abelmoschus esculenta, Hibiscus sabdariffa,* Black night shade, *Corchorus olitorius, Triumfetta* spp.
Guinea Savanna Zones (4)	1. Cassava based.	*Cucumeropsis mannii, Cucurbita maxima, Cucurbita moschata, Abelmoschus esculenta, Hibiscus cannabinus, H. sabdariffa.*
Sahel Savanna Zones		*Amaranthus spinosus, Celosia argentea, Ananosia degitata (*Bonbals leaves*), Gynandropsis gynandra, Citrullus lanatus, Cucumis melo, Cucurbita maxima, Cucurbita moschata , Vigna unguiculata, Abelmoschus esculenta, Hibiscus cannabinus, Hibiscus sabdariffa, Ficus dicranostyla, Moringa oleifera, Sesamum* spp, *Solanum aethiopicum, Corchorus olitorius.*

Source; Stevels, 1990

Table 2 The cropping systems of the different agro-ecological zones in Cameroon

Agro-ecological zone	Cropping system
Semi-humid Tropics (Zone 1)	Rootcrop based
Humid Rain Forest (Zone 2)	Rootcrop based
Highland Savanna (Zone 3)	Cereal based
Guinea Savanna (Zone 4)	Rootcrop based
Sahel Savanna (Zone 5)	Cereal based

The place of different indigenous vegetable species in the farming system of any agro-ecological zone depends on the consumption pattern of the native population and on the popularity of a particular species at national level. Thus, in the farms in each zone there are usually one or two vegetable species cherished by the native population and others are predominantly produced for the national market. In table 1 above, the five main agroecological zones and the principal species found in each is presented.

Semi-humid Zone

In this zone the farming system is rootcrop based and the main staple crop is cassava though in parts of the area cocoyam is also important. Though cassava is grown firstly for the roots, its cuttings are planted horizontally to induce many shoots from which leaves can be harvested. The leaves are a very important vegetable for the people in this zone. It is common to serve prepared cassava leaves with boiled cassava tubers, for all meals eaten during the day. Indigenous vegetables are often cultivated in cassava fields, in small patches and at the fringes but mainly in home gardens. Another species which is frequently found in this area, though not cultivated, is *Gnetum* spp (locally called 'eru'). About 5 to 10 years ago this vegetable was practically unknown to most Cameroonians except by the people from the forest areas. Presently there is a big demand for the leaves of this vine which is mostly harvested from the forest but sometimes from cassava fields where it grows as a weed. It is now very popular at national level across all cultural groups and it is also exported to neighbouring Nigeria.

The Humid Forest

The main difference between the humid and semi-humid forest zone is the rainfall pattern. Rainfall for the former is bimodal whereas the pattern for the latter is monomodal. Again, the highest concentration of vegetables are found in compound gardens especially during the dry season. Farming practices in the area have been influenced by settler populations, so that many fields are not planted with cocoyams or cassavas as the base crop, but instead with cereal crops, especially maize, and rootcrops have become secondary. The associated vegetables in these fields are mainly treated as minor crops. The prominent species in this zone are given in table 1.

Highland Savanna

This is basically a cereal growing area, and vegetables are minor crops within the system, unless harvested from major crops such as *macabo*, *colocasia* or cowpea plants. During the rainy season, they are planted as intercrops with *Xanthosoma sagittifolia*, Irish potatoes and pumpkins on huge burnt beds called "ankra". These are very fertile soils and the vegetables produced are very green.

It is common to find whole ridges planted with black nightshade, 'Njamajama', which is the most important vegetable in this area for both the indigenous population and settlers alike. Njamajama has also become very popular in other parts of the country. It is mostly served

with corn 'fufu', a popular food made from corn flour which is the main starchy staple for a large part of the population, but it can also be eaten with other starchy staples such as boiled macabo, cocoyam, potatoes, yams and plantain. Njamajama conveniently replaces meat in the diet, and thus is very highly demanded by all classes of people especially now that many people are becoming health and weight conscious.

It is common practice for farmers in this area to grow njamajama for the market intensively on the hills where there are fertile soils resulting from the grazing of cattle.

The Guinea Savanna

In this system rootcrops are central in the farming system. Cassava is the base crop and is mostly grown solitary. Indigenous vegetables are mostly intercropped with others such as *Abelmoschus, Curcumeropsis manii and Hibiscus sabdariffa* and others in table 1. However, *Hibiscus sabdariffa* is by far the most important vegetable of which both the calyx and leaves are eaten.

The Sahel Savanna

In this northern part of the country baobab (*Adansonia digitata*), *Hibiscus sabdariffa*, *Gynandropsis gynandra*, *Abelmoschus* spp. and *Celosia* spp are amongst the most popular indigenous vegetables. All the above species are served with the main dish, sorghum or corn "fufu".

During the rainy season, it is rare to see farms planted exclusively to vegetables. At that time, most traditional vegetables will be planted amongst other foodcrops. Leafy vegetables of all types are found in combination with other legumes. They are basically considered as minor crops in the system except when they are parts of major crops such as *macabo, colocasia*, cowpea, pumpkin and cassava. During this season, which is the main cropping season, there are usually many species that grow and flourish, even without receiving particular care, but in the dry season they disappear and only a few species are grown. At this time, in some areas, fresh vegetables come from shrubs and trees.

Thus, one finds a situation where the production of vegetables is limited by season. In the rainy season there is an abundance but in the dry season there is scarcity and prices shoot up. At that time farmers practice intensive cultivation of vegetables along streams and river banks or in home gardens to take advantage of the scarcity in order to make money. Off-season production is a major source of income for growers especially women. During this season, they are grown mostly as monocrops though sometimes also in mixed culture. Production becomes labour intensive because of the need to irrigate and protect crops from pests, including domestic pests in the case of home gardens and gardens around grazing land.

Outside Cameroon indigenous vegetables are sometimes considered as low-status food, whereas in Cameroon there are quite a good number of species that compete favourably with exotic types such as cabbages, tomatoes etc as mentioned in table 3. The table classifies most popular indigenous species into four categories based on their widespread adaptability in the farming systems across all agro-ecological zones, availability in major markets throughout the year and their consumption by all cultural groups within the country. It is common to serve these vegetables during lunch and dinner in one day. They are consumed by all households, irrespective of income and they are available in the markets all year round.

Table 3 The Level of Popularity of Predominant Species

A	B	C	D
Abelmoschus spp *Amaranthus* spp *Vernonia* spp Black night shade *Cucurbita* spp *Gnetum* spp	*Vigna unguiculata* (leaves)	*Solanum macrocapon* and *S. aethiopicum* *Talinum triangulare* *Telfairia occidentalis*	*Hibiscus sabdariffa* *Celosia* spp *Gynandropsis gynandra*

Group A Widely adapted to 3 out of 5 zones
Available during all seasons.
Presently can be considered as national dishes
Served as main part of a meal

Group B Widely adapted in all zones except in between *Xanthosoma* and *Colocasia*. The season affects availibility of fresh vegetables.

Group C Most important difference is that they are not main parts of the meal, use either as garnish or thickeners in sources.

Group D Widely adapted to all zones but onlyconsumed in pockets where they are known and used.

In the rainy season, vegetables are harvested either from cultivation or from volunteer plants found amongst a different crop. Those that volunteer easily are *Amaranthus* spp, *Talinum* and *Vernonia*.

USES OF INDIGENOUS VEGETABLES

These vegetables are used in many different ways both as food and medicine. However, the discussion about the medicinal value of certain spcies is beyond the scope of this paper. Unlike exotic species that can be used uncooked as salads and to decorate dishes, all indigenous vegetables must be cooked. Table 4 below describes how some of the popular species are prepared and used.

CONCLUSION

Despite their significant role that indigenous vegetables play in the diet of Cameroonians, no systematic research has been carried out to improve either their yield or quality. On the other hand, quite a lot of research work has been carried out on exotic types. Therefore, as far as indigenous vegetables are concerned, there is a big knowledge gap; there is limited information on the variations within species, no information on improved cultural practices and limited work on domestication of some species such as *Gnetum*. Also there is very limited information on post harvest techniques to take care of the excess production found in the rainy season.

In brief, we need to carry out research into breeding, agronomy, domestication and post harvest issues. The research areas can be highlighted as:

- **Breeding** for species improvement; better quality first, followed by quantity.

- **Agronomy;** improved cultural practices: planting dates, spacing, establish need for fertilizers, harvesting criteria, seed production, conservation and the usage of pesticides.

  Note: Leafy vegetables constitute a major source of income for rural women who face consumers who are constantly demanding quality products, notably luxuriant and large leaves free from insects. This has resulted in the indiscriminate use of chemicals.

- **Domestication;** Complete work on domestication of species like *Gnetum*. Presently highly demanded species like eru are still harvested from the forest. Though work on on-station domestication of the two species, *Gnetum africanum* and *G. buchholzianum*, is on-going, it is still far from finished.

- **Post Harvest;** There are large variations in supply and frequent gluts, therefore work on keeping produce over a longer period is necessary.

Table 4 : Preparation and Uses of Some Popular Species

Species	Preparation and Uses
Amaranth	The leaves and young shoots are cut up, blanched and cooked in oil. They are served as part of the main starchy staple e.g. plantains, yams, cocoyams, colocasia, sweet potatoes
Okra	The leaves and immature fruits are cut up and cooked in sauces which are typically thick and have a sticky texture. They are served with corn fufu (maize flour); garri, and water fufu.
Black nightshade	The leaves and young shoots are cut up and cooked in palm oil or other vegetable oil. They are served as part of the meal of corn fufu, plantains, cocoyams; and *colocasia*.
Eru (*Gnetum* spp)	The young leaves are cut up, mixed with leaves of *Talinum triangulare* and cooked in a lot of palm oil. They are served with cassava fufu (water fufu), 'garri', boiled plantains, cocoyams, yams, colocasia and other starchy foods.
Pumpkins	The fruits are eaten as a side dish and the seeds used to thicken sauces.
Cassava leaves	The leaves are cooked in palm oil and served with boiled cassava, plantains and other starchy foods.
Corchorus olitorius	The leaves are cut up and used to thicken sauces like okra soup and served with different types of "fufu".

MARKETING AND POST-HARVEST CONSTRAINTS OF TRADITIONAL VEGETABLES IN SUB-SAHARAN AFRICA

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ABSTRACT

Vegetables form a major part of the diet of many African people. Various leafy vegetables and native fruits are consumed but these vary between and within countries in Sub-Saharan Africa. Some traditional vegetables are still collected from the wild but many are grown within the compound near people's homes and on farms in the inland valley or wet sites, where large scale market gardening is practised.

Trade in some of these traditional vegetables is mainly local but is slowly changing to a regional and even international trade, particularly *Gnetum africanum, Amaranthus*, okra and fruits such as *Irvingia gabonensis* and *Dacryodes edulis*. Production is inefficient and little attention is paid to produce quality or its marketing. Efficient marketing systems are almost non-existent. A large proportion of traditional vegetables are rendered unsaleable on farms and in the markets as a result of poor post harvest handling and inefficient marketing systems. In west and central Africa this problem is particularly acute. Our study of four production sites in Nigeria showed that over 30% of leafy vegetables are lost on the farm or in markets.

If the immediate and strategic benefits inherent in the consumption of vegetables are to be realised, better production and more efficient post-harvest techniques will be needed. Marketing and post-harvest constraints are identified and research and development needs emphasised. Emphasis is placed on the Nigerian situation as a typical case in Sub-Saharan Africa.

INTRODUCTION

Vegetables form a major part of the rural diet in Africa and are a major source of Vitamin C (Ascorbic acid), dietary fibre, minerals, and proteins. Because of the nutritional importance of vegetables, it is essential to enhance all aspects of this source of food in order to improve the quality of the diet of consumers in Africa where animal protein is still expensive.

Improvement of agronomic practices and increased attention to post-harvest physiology and marketing are vital as it becomes clearer that improper management is causing large losses of produce that require large inputs of labour, materials and capital to grow (Wills et al, 1989). In the tropics and particularly in Africa, these losses can assume considerable economic and social importance. Post-harvest losses of horticultural crops such as soft fruits and leafy vegetables is immense. Unfortunately there are no accurate estimates but FAO suggest values of between 5 and 50% in four African countries (Table 1).

Table 1 Post-harvest losses of fruits and vegetables in some African countries

Country	% Loss	Produce
Ghana	30 - 35%	Fruits and vegetables
Nigeria	10 - 50%	Fruits
Rwanda	5 - 40%	Leafy vegetables
Sudan	50%	Fruits and vegetables

Source; FAO (1977).

TRADITIONAL VEGETABLES

African traditional vegetables can be classified into five groups (Table 2)

Table 2 Some traditional vegetables of SW Nigeria

Group	Latin name	Local name
Leafy vegetables	*Basella* spp.	Amunututu
	Celosia argentea	Soko
	Amaranthus spp.	Tete
	Corchorus olitorius	
	Abelmoschus caillei	
Fruit vegetables	*Abelmoscus esculentus*	Ila
	Solanum aethiopicum	Ikan
	Hibiscus sabdariffa	Isapa
	Trichosanthes cucumerina	Tomati elejo
Seed vegetables	*Citrullus lanatus*	Bara
	Cucumeropsis edulis .	Itoo
Pulses	*Vigna unguiculata*	Ewa
	Phaseolus lunatus	Awuje
	Sphenostylis stenocarpa	Otili
Spices	*Capsicum* spp.	Ata

Trees and shrubs also constitute important sources of traditional leafy vegetables. In most cases very young and tender leaves are used which indigenous knowledge recognises as being very nutritious and of strategic value as they are usually dried and stored for use during periods of scarcity. *Veronia* spp. are still relatively wild and semi-domesticated but now constitute a major component of the compound farm garden in West and Central Africa. They are particularly important in Cameroon where they are called 'bitter leaf'.

Table 3 Tree and Shrub Sources of Leafy Vegetables in Nigeria

Species	Ecology	Type of Leaf Used
Trees		
Ceiba pentandra	Forest/savanna	Young leaves
Myrianthus arboreus	Forests	Young leaves
Adansonia digitata	Savanna	Mature & young leaves
Pterocarpus milbraedi	Forests	Young leaves
Pterocarpus santalinoides	Forest/savanna	Young leaves
Shrubs		
Vernonia amygdalina	Forest/savanna	Young and mature
*Vernonia colorata**	Forests	Young and mature
Vernonia calvoana	Forests	Young and mature

* Non-perennial

DOMESTIC AND INTERNATIONAL TRADE IN TRADITIONAL VEGETABLES

Local markets constitute the main outlets for traditional vegetables in Africa. However, other markets exist, such as neighbouring countries' markets. Local markets are usually within localities or between sites of production and consumption. A good example is the Otte (near Ilorin, Nigeria) vegetable production area for Amaranthus and Celosia. Vegetables are transported from Otte (SW Nigeria) to Lagos, a distance of 250 km. A system of harvesting has been developed whereby crops are harvested at a time of the day to coincide with transport and arrival in Lagos.

In other cases the distance is between 1 and 10 km to the market or the trading post. Two examples of these were identified within Ibadan during field visits.

Within west and central Africa, international trade in traditional vegetables and fruits has commenced. For this, hardy vegetables and fruits are favoured. As an example, the vegetable *Gnetum africanum* is collected from the high forests in SE Nigeria and SW Cameroon from where it is transported to SE and SW Nigeria where it is purchased by Ibos.

CASE STUDIES

To provide specific examples of marketing constraints and post harvest problems in vegetable production in Nigeria, four sites were visited. Details are provided below.

Otte, near Ilorin, Nigeria

This production area is within the transition forest zone close to Ilorin, the State Capital. The main vegetables produced are *Amaranthus* spp. Very little of the vegetables are sold in Ilorin and nearly 90% are transported to Lagos which is over 280 km away. Major problems include wilting and attack by insect pests which reduces their market value.

Post-harvest management problems are immense, and these are common in the market places where wilting and leaf discoloration as a result of heat stress can be seen. Lack of harvest standards and non-uniform planting materials add to the heterogeneous quality on offer. Over 30% of vegetables produced is lost prior or during the marketing stage

Ihiala, South-East Nigeria

Vegetables grown here are mainly *Pterocarpus milbraedii, Vernonia amygdalina* and fluted pumpkin. *Gnetum* is processed by slicing and drying before marketing. This is a very important leafy vegetable which is usually transported to most Ibo cities for sale. Marketing and post-harvest problems are wilting during transport and insect attack.

Ibadan, Market gardening

Vegetables grown at this site include Amaranth, *Corchorus olitorus* and *Celosia argentea*. Here farmers save their own seed so stock is usually more uniform but production here also has immense problems. Wilting is a major post-harvest problem. The problem of insect attack is less evident as chemicals are used excessively which, in turn, has affected consumer confidence.

Bode Sadu, Nigeria

The main species produced in Bode Sadu is okra. Production is both during the rainy and during the dry season, when farmers get a lot more money from their produce from this lowland river valley. Okra keeps very well after harvesting and so stocks are usually held. However, over-production at this site coupled with a lack of transport reduces prices to farmers at most times. The excess okra are sliced, dried and stored away by farmers for sale at a later date. When storage pests are not too serious, okra can store for more than 6 months but pests seem to be a major problem and are the main cause of losses.

MARKETING CONSTRAINTS

Jimenez (1983) enumerated the factors affecting market quality of horticultural produce. He emphasised that marketing of horticultural produce is complicated by their individual characteristics.

- Farm products are produced in small quantities on many widely scattered rural farms.
- Farmers are poor at judging market conditions which leads to price instability
- Horticultural crops are produced seasonally, while consumers demand them all year round.
- Many horticultural products are highly perishable.

Factors affecting market quality of horticultural crops include the maturity of produce, careful handling, temperature, environmental variables and sanitation conditions. Martin (1979) assessed the status of vegetable marketing and concluded that traditional small-scale markets have fulfilled important economic and social functions in the past but are now becoming inadequate to meet the demands of the modern consumer in this region because;

- Supportive market information is poor
- There is a lack of homogeneity in farm produce since commodity standardisation is often lacking.

This has resulted in returns to producers and traders being low whilst the cost of marketing is high.

POST-HARVEST CONSTRAINTS

Vegetables demand careful attention at every stage from before harvest through to consumption, if product quality is to be achieved and maintained (Proctor 1985). Traditional African vegetables present special problems in both transport and storage because they are generally more perishable under tropical conditions with high temperatures coupled with a high moisture. Special problems are also caused by pests and diseases.

Factors affecting post-harvest losses include initial quality, temperature, relative humidity, sorting, grading and packing. Accordingly, we need to consider our field operations and product preparation for transportation and where possible avoid high temperatures and high humidity.

CONCLUSION

An analysis of the case studies indicates the following research needs;

Marketing

- Market information for traditional vegetables is poor and there is a great need for a census of types of vegetables, their volumes and price fluctuations throughout the year in different types of markets.
- There is the need for a census on production to determine what part is for home and community use, how much is supplied to local and regional markets and what percentage is lost or remains unsold.
- Market Research is needed into farmer and consumer preferences for indigenous vegetables.

Post-Harvest Losses

This is presently a neglected area of study. Despite the high costs involved in post-harvest processes, we need to collect sufficient data to allow for future development. Areas to be looked into include:

- Cooling of produce
- Drying
- Constraints to storage
- Humidification in relation to shelf-life
- Studies on the physiological and biochemical changes that occur in traditional fruits and leafy vegetables
- Diseases and pest problems in pre- and post-harvest stages of vegetable production including the development of integrated control systems.

POST-HARVEST HANDLING, PROCESSING AND PRESERVATION OF INDIGENOUS VEGETABLES IN CAMEROON; PROBLEMS AND CONSTRAINTS.

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INTRODUCTION

Indigenous vegetables are part and parcel of the daily diets of nearly all Cameroonians. They are generally prepared and eaten as soups and stews that accompany starchy main dishes or they are added to other foods as condiments to provide taste and flavour. Some are simply eaten raw such as garden eggs or boiled, roasted or baked and eaten as part of the main meal. Vegetables are an important source of vitamins minerals and proteins and are a vital part of the diet of the many households whose food is mainly composed of starchy products.

There are a wide range of crop species that are sources of green vegetables. Some are cultivated while others are simply gathered from the wild. Stevels identified sixty-seven vegetable species that are used as food in Cameroon. A number of them are gaining market potential, particularly in the urban markets and are an important source of income for many families in the peri-urban areas.

Despite the obvious importance of these groups of crops, very little attention is paid to them in terms of research or resource allocation. They are not included in the Regular Agricultural Census conducted by the Ministry of Agriculture. There is also very little research information on their production and post-production systems in the country. Production is fragmented and many of the important and highly demanded species are still under-developed.

The high demand, particularly by the urban population, for some species (eg *Amaranthus, Telfairia, Talinum, Vernonia and Gnetum*) implies that production will increase in the near future. This also means that the existing methods of handling, processing and preservation must be radically improved or completely changed in order to reduce the enormous losses that occur and are likely to increase with increased volume.

EXISTING TECHNOLOGIES

Indigenous leafy vegetables are highly perishable. As such very few efficient methods of handling, processing or preservation exist in the traditional systems (Numfor, 1997). After harvest, many of them are immediately utilized. Those intended for marketing are harvested a day before or early on the market day. Those that are transported to distant urban centres often arrive in very poor condition as the leaves are simply wilting away.

A few species such as bitter leaf and the leaves of cowpeas are sometimes preserved through dehydration. They are usually dried in the sun or over the hearth and stored in calabashes or similar containers. Dried bitter leaf and cow pea leaves are reported to keep well for over a year. When needed, they are simply rehydrated and used (Numfor, 1987). Other preservation techniques such as fermentation, refrigeration, freezing, etc are not presently being used on a wide scale.

PROBLEMS AND INTERVENTION POSSIBILITIES

There is some existing knowledge on handling, processing and preserving vegetables in Cameroon. This indigenous knowledge is applied to most vegetables that are found in the local markets today. Although the existing methods of handling, processing and preserving vegetables appear to be appropriate to the local situation, current demographic and social changes call for their improvement to make them more acceptable to modern consumers. Existing methods still rely heavily on manual labour, crude and unreliable handling methods with inappropriate packaging, inadequate sanitation, poor presentation and no set standards of any kind.

To devise efficient post-harvest systems requires intervention of numerous services including research, education, communication, transport infrastructure, improvement on raw materials etc.

Table 1 Postharvest Possibilities with Selected Indigenous Leafy Vegetables

Vegetable *(Scientific Name)*	**Part used**	**Traditional Preservation**	**Other Preservation Possibilities**	**Processing Possibilities**
Garden eggs *(Solanum aethiopicum)*	Fruits	Dehydration	Refrigeration	Size reduction, drying, milling
Water leaf *(Talinum triangulare)*	Leaves	None	Refrigeration	Sorting/packaging
Bitter leaf *(Vernonia hymenolepis)*	Leaves	Dehydration	Refrigeration/ freezing	Size reduction, dehydration, packaging
Cow pea *(Vigna unguiculata)*	Leaves	Dehydration	Refrigeration	Sorting, dehydration, packaging.
"Eru" *(Gnetum spp)*	Leaves	Dehydration	Refrigeration, freezing ?	Size reduction, dehydration, packaging.
Cassava *(Manihot esculenta)*	Leaves	None	Refrigeration, freezing ?	Size reduction, packaging.

Harvesting and Handling

Crop harvesting and handling is generally carried out manually but with increased production the system becomes inefficient. There is a need to develop affordable and more efficient methods and implements that could increase efficiency and improve on the hygiene and sanitation.

Storage system

Improved and cost effective storage systems must be developed. Crop production is indirectly affected by storage structures and techniques. Poor storage techniques can be blamed for a major portion of post-harvest losses presently encountered. Usually, after a bumper harvest, most farmers get discouraged when a large proportion of their crop is lost due to a lack of adequate storage and marketing opportunities.

Also, the current and popular belief that fresh fruits and vegetables can greatly contribute to good health calls for greater effort in the development of appropriate storage systems that can preserve these fruits and vegetables in their natural state for extended periods. The development of large urban centres implies a need for large scale food supplies. Adequate and efficient storage structures and techniques are vital for handling such large supplies both at the production and distribution centres.

Processing and preservation techniques

Appropriate labour saving devices and machinery as well as new techniques to improve sanitary systems are needed to replace manual handling. Priority must be given to sanitation and nutrition in any new developments. The complete dependence on human labour, though necessary for job opportunities, is often a disadvantage as far as food hygiene is concerned.

Avoiding unnecessary waste

Farmers and traders are used to transport produce to the urban areas in a raw form such as eru leaves attached to their vines. Unusable bulky parts such as stalks become a big problem to the city's waste disposal systems. The disposal of waste or unwanted by-products may not be significant when considering home or cottage operations but it becomes highly significant in large scale city situations. It is therefore necessary that farm gate pre-processing be developed and encouraged.

Diversification of uses

Traditional vegetables can be used for other purposes such as medicines and animal feed. For example, cassava leaves can be used as animal feed.

Fast Foods

With urbanization and time consciousness, many people no longer have the time nor like the drudgery involved in traditional food processing and preparation methods. There is a need to develop fast foods from our vegetables. This will particularly relieve the female members of the society from time-consuming and labour intensive food preparation.

Analytical Data

The shortcomings of indigenous vegetables are directly related to the lack of basic chemical, physical and organoleptic information on these crops. Plant breeders, agronomists, nutritionists, food scientists, food technologists and others need to co-operate in providing this basic data which is essential for any formulations of food or feeds from such local materials.

Export Opportunities

There is a tendency to think that indigenous vegetables cannot be exported profitably like the so-called cash crops (coffee, cocoa, cotton, palmoil etc.). This is so because they have always been considered inferior and not developed to meet export standards. However, these crops can be a good source of foreign exchange if both production and post production systems are improved in order to produce high quality products. Research effort should be geared towards making these crops competitive in the world market in terms of quantities and quality. Already stories abound that several of our crops, such as the African eggplant, are being developed outside Africa and are becoming increasingly important internationally.

Gender Issues

In the traditional system, women carry out most of the production and post-production operations on vegetables. This division of labour which is weighted unfavourably against

women, is often a handicap to further development. This socio-economic constraint must be taken into account in any efforts towards improving the post-harvest system.

Information Dissemination

A lot of information on improved technologies has already been generated by both national and international research bodies but has not yet been brought to the attention of the final users (farmers, food processors, etc). Some of this information can be effectively adapted to the indigenous vegetables. While it is necessary to continue to research into the systems for possible improvements, it is equally important to proceed with the dissemination of the existing improved technologies adaptable to our local vegetables.

IDENTIFICATION OF VEGETABLES IN FAKO MARKETS

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INTRODUCTION

Muea and Muyuka markets are situated on the Eastern side of Mount Cameroon. While Muea is on the colder volcanic flanks, Muyuka is in the hot sedimentary basin of the Mungo flood plains. In both areas, vegetables are a large proportion of the crops grown. In these markets both exotic and indigenous vegetables exist. While the exotic types are either brought in from elsewhere or grown using advanced methods, traditional methods are used to produce the indigenous ones. Such indigenous vegetables are seen to compete with corresponding root or seed crops also consumed in the area and seen in the markets. Traditional vegetables show significant variation in types and appearance.

Both Muea and Muyuka markets supply urban traders or "buyam-sellams" from within the region and from cities like Limbe and Douala etc.

SURVEY METHODOLOGY

Muea and Muyuka markets were surveyed to identify the range of vegetables offered. After discussing with traders and buyers, the vegetable were regrouped into exotic and indigenous types.

RESULT AND DISCUSSIONS

In the markets, traders and buyers attached different importance to different vegetables relative to their origin, susceptibility to pests and diseases and their palatability (tables 1 and 2). Certain vegetables co-exist in the market as indicated by both traders and buyers. The fact that there was much more Eru in Muyuka than in Muea created the presence of more water leaf in this market as explained by the fact that Eru is prepared using water leaf as a softener. Eru on the other hand is present during both seasons but found more in Muyuka market which is nearer to the forest source on the eastern flank of Mount Cameroon.

Exotic vegetables (carrot, cabbage, green beans, onions, tomatoes and green pepper) are brought from highland areas such as Foumbot, Bamenda and Dschang. They fetch higher prices during the dry season when local crops are scarce. Indigenous vegetables are similarly more scarce and expensiveduring the dry season. Green (*Amaranthus* spp) is mainly produced during the dry season under irrigated conditions using sprinklers.

Vegetables like cocoyam leaves were sold alongside their tubers. Hence the exotic Xanthosoma's scarcity could be explained by the competition between leave versus root production.

Table 1 Vegetables found in Muea market

Vegetables	Exotic or indigenous	Type identified/comments
Bitterleaf *(Vernonia anygdalina)*	Indigenous	Sweet - favoured by insects Bitter white - less favoured by insects Bitter black - less favoured by insects
Fluted pumpkin or gourd *(Telfairia occidentalis)*	Indigenous okongobong Origin; Nigeria-Ogu	Edible young seeds. Mature seeds for oil Vines eaten as vegetable
Green (*Amaranthus* spp)	Indigenous and Exotic	Sold mainly from farms
Igbo leaf (Oha)	Indigenous	Eaten by Igbos
Cocoyam leaves *(Colocassia esculenta)*	Indigenous taro	Compete with edible tubers
Tomatoes	exotic	Buea - large and fleshly Muea - medium and fleshly Foumbot - small and eggshaped Dschang - sweet and eggshaped
Waterleaf *(Talinum triangulare)*	Indigenous, mainly wild	Used to prepare Eru
Okro	Indigenous	Tiko - long and white Buea - short and black
Ginger	Exotic	Grown in Muea
Pepper	Traditional but exotic	Buea - roundand stunted Tole - eggshaped and medium Foumbot - yellow, red and long Bamenda - small and tiny Bush - tiny and rounded NTFP*
Eru (*Gnetum africanum*)	Indigenous vines growing on trees	Non timber forest product -via buyam-sellams
Huckle berry (*Solanum scabrum*)	Indigenous (African spinach)	Bamoun - big white leaves Local - small white leaves Bamenda - small black leaves
Carrots, celery, cabbage, green beans, parsley, sweet pepper and leeks	Exotic	Foumbot - exotic Upper farms - local

*NTFP - Non-timber forest product

Three different market channels were identified during the study;

1. **The long channel**, involving several middlemen and buyam-sellams and often long-distance transport . This was found to apply to eru and onions.
2. **Use of only one or two intermediaries**. This applies especially to amaranth which is not readily available in the market since most produce is sent by traders to people in Douala and other cities. Local people buy at farm gate
3. **Immediate sales**. This applies to most indigenous vegetables which are sold directly on the markets by producers themselves or through farm-gate sales.

Table 2 Vegetables identified in Muyuka

Vegetable	Exotic or indigenous	Type identified/comments
Bitterleaf (*Vernonia amygdalina)*	Indigenous	Sweet - suseceptible to insect attack
Fluted pumpkin or gourd (*Telfairia occidentalis*)	Indigenous okongobong Exotic from Nigeria-Ogu	Young seeds edible Mature seeds planted for oil
Green (*Amaranthus* spp)	Indigenous and exotic	Very limited - already bought
Cocoyam leaves (*Colocasia esculenta*)	Indigenous and exotic	Taro and *Xanthosoma* Compete with edible tubers
Tomatoes	Traditional and exotic	Muyuka red, medium, irregular and fleshly Muyuka red round
Waterleaf (*Talium triangulare*)	Indigenous, common weed	Used to prepare Eru
Okro	Indigenous	Tiko - long and white
Ginger	Traditional	Grown in Muea
Pepper	Traditional and exotic	Muyuka yellow, red and long Bush tiny and rounded NFTP*
Eru (*Gnetum africanum*)	Indigenous vegetable found in trees	Non timber forest product
Huckleberry- (*Solanum scabrum*)	Indigenous	Local - small white leaves Local - small black leaves
Carrots, celery, cabbage, green beans, parsley, sweet pepper and leeks	Exotic	Foumbot - exotic Upper farms - local

Table 3 Vegetables that compete with other crop forms

Vegetables	Parts in competition with	Comments
Cocoyam leaves	Tubers	Both present in market but limited leaves
Cassava leaves	Tubers	No leaves in market now
Telfairia leaves	Seeds	No seeds in market now
Amaranth	Seeds for grain use	No seeds in market now

Conclusion

Vegetable marketing has not been researchered in the coastal humid forest zone despite the importance of vegetables as both food and/or cash crops to all households. This study on the availability of indigenous and some exotic vegetables in two strategic Fako markets will hopefully initiate more detailed country-wide studies on the demand and supply of vegetables in both urban and rural areas, including pricing at various times of the year.

COMPARING NUTRITIONAL VALUES OF EXOTIC AND INDIGENOUS VEGETABLES

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INTRODUCTION

In sub-Saharan Africa, the per capita consumption of vegetables is far below the recommended daily intake of 200 grams of which about two thirds should be green leafy vegetables. The observation made in 1964 by Oömen on the under-utilisation of indigenous green vegetables amidst widespread nutrient deficiency symptoms like xerophthalmia and anaemia is as valid today as it was three decades ago.

Malnutrition and deficiency diseases are sometimes the result of ignorance and poverty. In urban areas, many vegetables are scarce or expensive, and the tendency of the low income group is therefore to consume cheap and readily available starchy staples. Ignorance contributes to malnutrition in two ways; among the illiterate or nutritionally uninformed, there is a lack of knowledge about nutrition generally whilst people with a higher educational background are not aware of the nutritional values of indigenous plant species. The agricultural system is western oriented and emphasises cultivation of western species. Seed of exotic vegetables are readily available whereas seeds of indigenous crops can hardly be found.

There are many vegetable species available for cultivation, both local and exotic. Which species a farmer decides to grow should depend on the physical, economic and social environments and the crop's nutritional importance. A choice has to be made between an indigenous vegetable, e.g. *Amaranthus*, and an exotic species such as cabbage. However, in East Africa most farmers prefer to cultivate exotic species for sale, without regard to their nutritional values, because they command higher prices. This preference even applies in the rainy season when many exotic species grow poorly.

Some indigenous vegetables are strategic reserves of nutrients during critical periods e.g. the relish gap, and in some rural areas, survival could be greatly threatened without them.

Nutritional anthropologists believe that people's consumption habits are based on three factors: what is available, what they can afford and what are they used to. Yet the balance between indigenous and exotic vegetables in Africa seem to contradict some of these factors. Exotic species are expensive to produce and purchase, are foreign to the palates of local people and yet they displace indigenous ones.

COMPARING NUTRITIVE VALUES

There are numerous reports of studies undertaken to determine the chemical composition and nutritional value of tropical vegetables, most of which are inventories covering specific nutrients. Few comparisons have been made between the overall nutritive values of indigenous and exotic species. Table 1 is a compendium of analyses.

Often certain vegetables are associated with specific nutrients e.g. carrot for β-carotenes (pro-Vitamin-A), dark green vegetables with iron, dietary fibre, pro-Vitamin A and leguminous seeds with protein.

Table 1 Nutrient Content of some Indigenous and Exotic Vegetables. Nutrients per 100g edible portion

Vegetable	H_2O	Protein (g)	Fibre (g)	Calcium (mg)	Iron (mg)	β-Carotene (mg)	Vitamin C (mg)
Cleome***	83	6.0	1.6	300	6.8	1100	132
Amaranth*	85	5.0	1.5	250	4.0	1800	100
Kale**	84	3.5	1.6	122	1.3	900	110
Cabbage*	93	1.5	0.8	40	0.5	18	40
Swiss Chard*	92	2.0	0.4	132	0.7	600	50

Sources * Platt, (1962) ** FAO (1968) *** Chweya (1990)

When comparing nutrient contents it is necessary to adjust for the fact that dry matter varies not only between species but even between crops as it is influenced by the level of fertility, water stress, general environmental conditions, stage of maturity and post-harvest handling. Even though crops are not generally consumed dry, comparisons should be made on the basis of nutrients per unit dry weight.

It has been observed by Grubben (1977) that there is no evidence that tropical leafy vegetables are more nutritious than temperate dark green leafy vegetables, when compared on a dry weight basis. However, they are more nutritious than pale green vegetables.

COMPARING INDIVIDUAL NUTRIENTS

Individual nutrients can be targeted in nutritional intervention programmes. Most data for calcium, iron and carotene content, reveal that indigenous vegetables contain more of these nutrients than exotics. Two significant nutrients, lysine and folic acid are examined;

Lysine, an essential amino acid is deficient in diets based on cereals and tubers which are common in Sub-Saharan Africa. A diet that includes cereals and green leafy vegetables alleviates this deficiency.

Table 2 Lysine Content of some Vegetables compared with Amaranth
After Gupta and Wagle (1988)

Vegetable	**Lysine (% dw)**
Chenopodium	0.31
Spinach	1.98
Cauliflower	2.99
Chickpea	3.07
Mustard	3.22
Amaranth*	5.60

Source; Prakash and Pal (1990)

Folic acid has received increasing interest since its deficiency results in megaloblastic anaemia, prevalent among pregnant women in developing countries. The anaemia of kwashiorkor, for example, is usually megaloblastic and is responsive to a combination of dietary protein, supplementary iron and folic acid. Although iron deficiency anaemia is the predominant type, other anaemia are attributable to deficiencies of folates of which green vegetables are very good sources.

In a study by Chen and Saad (1981), *Corchorus olitorius* contained higher total folacin than spinach and broccoli which are the leading exotic vegetables in folacin content (table 3).

Table 3 Folacin Content of some Vegetables (Perloff and Butrum, 1977)

Vegetable	Total Folacin content mg/100g
Corchorus olitorius (raw)*	800
Corchorus olitorius (dried)*	1132
Spinach (raw)	193
Spinach (cooked)	91
Broccoli (raw)	105
Romaine lettuce (raw)	179
Brussels sprouts (raw)	78
Cabbage (raw)	66
Asparagus (raw)	64
Green beans (raw)	44
Cauliflower (raw)	55

* Data from Chen and Saad, 1981.

NUTRITIONAL RANKING OF VEGETABLE SPECIES

Essential nutrients supplied by vegetables include protein, dietary fibre, calcium, iron and vitamins A and C. Using data based on European dietary situations, a well balanced daily intake of 100g of vegetable provided the following to the Recommended Daily Allowance (RDA); one-fifth of protein, half of iron, one-third of carotene and one hundred-fold vitamin C requirement. Rinno (1965) developed a formula to express the cumulative value of these nutrients. In 1977 Grubben modified this formula to develop the concept of 'Average Nutritive Value' (ANV) viz;

$$ANV = \frac{\text{protein (g)}}{5} + \text{fibre (g)} + \frac{\text{Calcium (mg)}}{100} + \frac{\text{Iron (mg)}}{2} + \text{Carotene (mg)} + \frac{\text{Vitamin C (mg)}}{40}$$

This formula can be used to make a quantitive assessment of the ranking of different types of vegetables (table 4). Such a ranking suggests that indigenous vegetables are much more nutritious than exotic types.

Table 4 Average Nutritive Values of some Idigenous and Exotic Vegetables

Vegetable		Average Nutritive Value (ANV)
Leaf: Indigenous	Amaranth	11.32
	Cassava leaves	16.67
Leaf: Exotic	Lettuce	5.35
	Kangkong	7.57
	Cabbage (white)	3.52
	Chinese Cabbage	6.99
Legume	Mungbean	2.94
Other	Onion	2.05
	Carrot	6.48
	Pepper (sweet)	6.61
	Watermelon	0.90
	Eggplant	2.14
	Tomato	2.39

OVERALL NUTRITIONAL QUALITY COMPARISON

The contribution of particular nutrients to the Recommended Daily Allowances (RDA) is a measure of a vegetable's importance in feeding programs and justifies the utilisation of that species in diets. The contribution of various indigenous leafy species to RDA for Vitamins A and C, and minerals Ca++ and Fe++ (Imungi, 1989) are depicted in table 5.

Table 5: % Contribution to RDA by some Indigenous Leafy Vegetables

Vegetable Species	%RDA (Raw Leaves)			
	Vit. A	Vit. C	Ca	Fe
Gynandropsis gynandra	196	437	56	80
Solanum migrum	122	210	27	34
Amaranths spp	170	320	100	34
Crotalaria brevidens	131	420	32	28
Corchorus olitorius	113	521	32	56
Cucurbita spp	110	467	5	17
Vigna spp	150	260	110	35

(after Imungi, 1989)

ANTI-NUTRITIONAL FACTORS

Although rich in nutrients, indigenous leafy vegetables generally have high levels of anti-nutritional factors.

Oxalic Acid

Oxalic acid is present in many green leafy vegetables. Vegetables belonging to the sub-class Caryophyllidae are high in oxalic acid and examples are given in table 6. The action of oxalic acid is to bind bivalent cations, rendering them unavailable. Ca++, Mg++ and Fe++ are bound as insoluble oxalates and are eliminated through the alimentary canal. Thus high Ca++ content in a leafy vegetable species is meaningless unless the oxalic acid level is known. The ratio of Ca++ to oxalic acid of >1 is ideal. Ratios of 0.2 occur in *Amaranthus* and have been reported as very unsatisfactory (Singh; 1973).

Table 6 Families in the Sub-class Caryophillidae and Vegetables Rich in Oxalic Acid.

Family	Edible Vegetables
Aizoaceae	*Tetragonia expansa* (New Zealand Spinach)
Amaranthaceae	*Amaranthus* spp *Celosia* spp
Basellaceae	*Basella spp*
Chenopodiaceae	*Spinacea oleracea* (Spinach) *Beta vulgaris cicla* (Swiss Chard) *Atriplex spp* (quinoa)
Polygonaceae	*Rheum raponticum* (Rhubarb) *Rumex* *Oxygonium sinuatum*
Portulacaceae	*Portulaca oleracea* *Talinum triangulare*

Oxalates of monovalent cations Na+ and K+ are soluble, and have physiological implications in oxaluria and renal calculi formation. Grubben, (1979) and Marderosian et al (1979) have observed that unless a person consumes >200g per day of high oxalate vegetables, there is no danger of poisoning. Boiling vegetables and decanting the cooking water is an effective method of removing oxalic acid but water soluble vitamins and other nutrients are also lost.

Nitrates

Most indigenous leafy vegetables are nitrophiles, suggesting that they evolved around decomposed organisms. They are accumulators of nitrates which when ingested are transformed into nitrites. These then combine with haemoglobin to form methaemoglobin, and at levels >500 mg/100g dw, cyanosis ensues. Nitrite is particularly dangerous to children. The conversion of nitrite to nitrosamines which are mutagenic has also been shown to occur. Appropriate cultural techniques to reduce nitrate levels in vegetables is important in Africa where green leafy species constitute a more significant portion of the diet. Deficiency of molybdenum in soils, a co-factor in the Nitrate Reductase enzyme, often leads to nitrate accumulation in leaves, hence its status in the soil should be monitored and corrected if deficient.

Glucosinolates

Leafy Brassica vegetables e.g. kale, cabbage, collards and Ethiopian kale are frequently consumed in the cooler areas of Africa. They have glucosinolates enzymatic breakdown, products of which are goitrogenic. Ethiopian kale leaves have less glucosinolates than rape (Mnzava et al., 1985) and therefore should be promoted rather than rape.

Phenolics and 'Bitter Principles'

Phenolic compounds, notably tannins, impart an astringent taste to vegetables and bind protein, hence reducing its availability. They are mostly found in unimproved species, and collectively with other antimetabalites are called 'bitter principles'. These can be reduced by decanting cooking water. *Gynandropsis gynandra* and *Solanum nigrum* contain appreciable amounts of phenolics. Most exotic species do not contain them.

Glycoalkaloids

Solanaceous vegetables e.g. African eggplant (*Solanum aethiopicum* and *S. macrocarpon*) and nightshade (*Solanum nigrum*) contain the glycoalkaloid, solanine, as well as toxic and bitter substances. They are synthesised in response to abiotic stresses, and culinary, agronomic and genetic improvements can reduce them. All members of the Solanaceae family whether native or exotic (e.g. tomatoes and potatoes), contain these compounds.

Cyanogenic Glucosides

Cyanogenic glucosides are found in cassava leaves and sweet potatoes. Choice of low HCN clones and a proper production environment and fertilization ensure low intakes.

Phytic acid

Phytic acid is found particularly in legume seeds. It has also been found by Bawa and Yadav (1986) in indigenous leafy vegetables. It binds phosphorus and other minerals making them unavailable.

Pesticide residues

Exotic vegetable are probably more susceptible to pests and diseases than indigenous ones and farmers frequently use pesticdes as a control measure. Pesticide contamination renders their produce nutritionally hazardous. Indigenous species are not normally produced on a large scale as monocrops and are rarely sprayed. This, however, is not the case for crops such as garden eggs grown on a large scale in west Africa where farmers use chemicals.

The presence of anti-nutritional factors tends to lower the otherwise high nutritional value of indigenous vegetables. However, most of these anti-metabolites are common to leafy vegetable types whether indigenous or exotic, and should not be seen as being unique to unimproved African species.

SUMMARY

The ultimate comparison between indigenous and exotic vegetables is through their nutritional values. Existing evidence so far suggests that, in general, Africa's indegenous leafy vegetables are endowed with higher levels of nutrients than their exotic counterparts.

DEVELOPING NEW VARIETIES OF INDIGENOUS VEGETABLES

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INTRODUCTION

Horticultural research is generally aimed at improving the growers' income through the release of technical packages and better performing varieties. In tropical zones, average yields of vegetables are generally low, ranging from 12 to 15 tons/ha or even less. Indigenous vegetables have been neglected for a long time even though they play a key role in the diet of rural communities. The main aim of breeding is to select or create good planting material to meet the users' requirements with particular regard to yield, quality, resistance to pests, diseases and stress factors.

In this paper I will describe the general guidelines and some breeding methods to be used for the genetic improvement of African eggplants, Okra and Roselle.

INITIATING AND CARRYING OUT A BREEDING PROGRAMME.

Defining the breeding objectives.

A breeding programme is aimed at solving one or several problems. Defining the breeding objectives should be based on a good knowledge of the problems involved.
The breeding issue should be identified and prioritized by the breeder through a demand as expressed by growers from representative production areas. Breeding objectives are various and generally relevant to yield, adaptation to climate, morphological attributes, taste or resistance.

Seeking sources of variability.

Once the objectives are clearly defined, the next step is to obtain and identify the sources of genes or gene complexes controlling the desired characters. This operation should be carried out through plant collections at local level from growing areas and, if needed, introduction from neighbouring countries or even further afield to obtain local and old commercial cultivars, closely related species, etc. Then this materiel should be codified and registered, first in a notebook with vernacular names, origin, known characters, etc. and where possible data processed.

Plant Genetic Resource (PGR) evaluation and characterisation.

The genotypes collected should be sown under precise growing conditions for description of characters and other study purposes. For morphological and quantitative attributes such as earliness, yield components, etc., characterisation and evaluation may include the IPGRI descriptors, for further germplasm management. As for resistance, screening of the material collected is necessary and can be carried out either under natural or artificial conditions in a laboratory. These operations will allow us to have a better knowledge of the genetic material collected and the extent of genetic variability available including external traits, homozygosity, various resistances , yield, etc. The next step will consist of selecting genotypes based on the information collected, for inclusion in the breeding programme.

Table 1 Some Examples of Breeding Objectives and Sources of Genes.

Species	Breeding objectives	Sources of genes and references	Observations
Scarlet Eggplant *(Solanum aethiopicum)* Gboma Eggplant *(Solanum macrocarpon)*	Fruit size, colour, shape, taste Non dormant seeds High yield (leaves, fruits) Resistance to pests (mites, flower borer) and diseases *(Stemphylium, Alternaria)* Resistance to nematodes	Subspecies for *aethiopicum* (e.g *Gilo, Aculeatum)* and local cvs for both hairy leaved groups of *S. aethiopicum* (*Gilo, Aculeatum*) and *Solanum torvum*	Hairless leaves are edible (Kumba and Shum groups). *S. macrocarpon* is resistant to mites
West African Okra *(Abelmoschus caillei)*	Pod shape, colour and sliminess High yield* Resistance to *Fusarium oxysporum* and nematodes *(Meloïdogyne spp)* Resistance to nematodes *(Meloidogyne spp).*	Different cvs of *A. caillei* or A. *esculentus* Cvs of *A. caillei* *A. manihot and A.moschatus* *A.manihot*	* Yield is correlated to certain components such as number of branches, fruit number and weight
Karkade or roselle *(Hibiscus sabdariffa)*	Uniformity for useful traits* High leaf and calyx yield High and stable anthocyanin content** (red cvs) High acidity** and vitamin C content Resistance to *Phytophtora* sp (*H. cannabinus)*	Different cvs of *H. sabdariffa* *Hibiscus cannabinus* (1)	* Most cvs are heterogenous as a result of lack of maintenance ** Acidity and anthocyanin content are not correlated

Notes; 1) - Stone and Alconero, 1973

Adopting a breeding method.

PGR studies (evaluation and characterization) give the breeder an accurate knowledge of his material. At this stage and according to the objectives to be achieved, he will make a decision about how to exploit this variability. Prior to this, he should have sufficient information on some important aspects such as floral biology, taxonomy, inheritance of the major attributes, etc.

There is presently little information available on African vegetables compared with vegetables from the temperate zones. However, there are some observations on floral biology of the indigenous species involved, made personally and based on reports. From this we can choose a breeding method which will take the following factors into account :

- Mode of pollination and floral biology (cross and self pollinated plants and vegetatively propagated species are treated differently).
- Inheritance of the major traits considered; some characters are simply transmitted and others have a polygenic inheritance, because they can be controlled by more than one gene, the action of each one being sometimes complex.
- Breeding objectives; according to the variety, type and number of attributes considered, the breeding method will be different.

After evaluation and characterization, two cases can be considered. First, the desired variability is available within the varieties or populations tested but, because of heterozygosity, stabilization is needed prior to release. In such cases, '*conservative selection*' through selfings and mass selection is generally used. The latter method is often used both for cross and self pollinated species. Broadly speaking, it consists of growing many plants together for open pollination. When a certain degree of uniformity is achieved, selection will be negative and consist of roguing offtypes to stabilize the population. On the other hand, if several phenotypes have evolved in a given population, then the different phenotypes will be selfed and multiplied seperately to obtain a number of stable varieties.

The second case applies when the desired characters are scattered amongst at least two varieties, in which case, a new variety will be created through hybridization with different methods chosen based upon the factors mentioned above.

Hybridization can be intra or inter-specific according to the sources of genes obtained. Intraspecific crossings between cultivars, subspecies or botanical varieties are feasable without any technical constraint, but the variability needed is not always available within one species. Interspecific hybridization between two different species of a genus is in most cases difficult to achieve because hybridization is often prevented as a result of incompatibility. Some of these ones can be broken using specific techniques. A very common post-zygotic barrier is the sterility of the F1 as a result of meiotic abnormalities. In this case amphidiploidy is used to restore fertility.

Some examples :

- *Abelmoschus caillei* x *Abelmoschus manihot* (JAMBHALE et NERKAR, 1987)	partially fertile
-*Abelmoschus esculentus* x *Abelmoschus caillei* (HAMON, 1987)	
- *Hibiscus sabdariffa* x *Hibiscus cannabinus* (BOULANGER et al; 1984)	hybrids
- *Solanum aethiopicum* x *S. macrocarpon* (OMIDIJI, 1979)	
- *S. aethiopicum* x *S. torvum* (SECK, 1983) :	no offspring.

After hybridization there are two options in creative breeding, depending on the target type of varieties: For F1 varieties, the genitors chosen are tested for general and specific combination aptitudes. An example of such a testing method is *diallel* which consists of making a maximum number of crosses with the genitors 2 by 2, the total F1 combinations obtained with n genitors being n(n-1), i.e.10 genotypes will give 90 combinations. Then, the different combinations are tested at different levels prior to release. In this case, if the desired characters are only present in one parent, they necessarily should be controlled by dominant genes. At present times, several F1 hybrids of okra and indigenous eggplants are available.

For open-pollinated varieties, different methods can be chosen after obtaining the F1 hybrid. As a whole several breeding methods can be distinguished, based on the mode of pollination. They will not be fully described here but some of the most common ones are listed below :

* *Cross pollinated crops*	- Recurrent selection methods. - Family selection.
* *Vegetatively propagated crops*	- Clonal selection.
* *Self pollinated crops*	- Backcrossing - Pedigree method

This calssification of methods is not definitive. For example, recurrent selection and backcrossing have been respectively reported on okra and onion.

Okra, african eggplants and roselle are partially self pollinated species and therefore can be improved through pedigree and backcrossing. For example *Solanum aethiopicum* breeding in Senegal has lately resulted in high yield and mite resistant lines through pedigree selection. The F1s used were intersubspecific ones (*Gilo* x *Kumba* and *Aculeatum* x *Kumba*). In addition, breeding for absence of embryo dormancy has lately started through backcrossing (gene transfer between two local varieties), after dormancy was discovered to be controlled by a recessive gene or genes.

The Pedigree method is generally used when a certain number of dominant characters are to be combined from two parents into a new variety. In broad terms, the F1 is selfed to produce the F2. At this stage, many plants from one F2 compose a line or family. Each plant will then be selfed, and selection will be done between and within the different families. This process is followed with further selfings until varieties are stable enough to be tested for release.

Backcrossing is more appropriate when a limited number of dominant genes are involved and are to be transferred from one variety to another. The variety to be improved, the recurrent parent, is supposed to be altered by transfer of the desired allele(s) from the second variety or donor parent. Broadly speaking, the two genotypes are crossed to obtain the F1 which will be backcrossed with the recurent parent as many times as needed to obtain respectively backcross BC1, BC2, BC3, ...BCn. At each generation, plant selection will be based on the useful characters of the recurrent parent and the trait(s) to be transferred. If the latter is controlled by a recessive gene, recognizing plants with the new character will be difficult unless backcrossings are associated with selfing of each plant. Then, when after breeding new lines are very close to the recurrent parent, selection can go on through a pedigree method to stabilize them. Afterwards, new varieties obtained will be tested for release.

TESTING NEW VARIETIES

Newly stabilized or newly created varieties will at least be tested at three levels in order to have sufficient information on their behaviour for selection purposes at each level, prior to their release.

On-station and multi-locational trials

The breeder will carry out on-station trials of his new varieties in an appropriate design (yield trials) or under required conditions with sufficient stress (resistance). These trials will be located in as many areas and with as many replications as needed for comparative testing. Comparison will be made between the new varieties themselves, and also with control ones (local or improved). Afterwards, about 10 % or less of the varieties tested can be selected for further trials. All these trials are supposed to be carried out with uniformly set technical guidelines. Here yields are generally high, and not necessarily representative of the local cropping systems.

On-farm trials

The few well performing varieties which were selected in these trials are then tested under representative farming systems, generally characterized by extensive cropping practices. In extension work such trials are very important. In most African countries we will find that more than 90 % of all growers are small-scale vegetable producers due to their limited financial means, equipment, small land holding etc. In general, the average yields at this level are about 1.5 to 2.5 times lower when compared with on-station trials. Accordingly, on-farm trials should be located in selected farmers' fields and within their own cropping system together with their own varieties as control.

This is the last but not the least important step prior to seed production and commercialization should allow us to get a good inside knowledge of the introduced varieties that will result in either choice or dismissal. Besides, growers' behaviour towards this material is not only based on yield and resistance, but they also consider the commercial aspects and consumers' preferences.

Gnetum vine with fruits.

Gnetum leaves packed for export to Nigeria.

Dr. Patrick Shiembo showing a rooted *Gnetum* cutting.

Gnetum nursery.

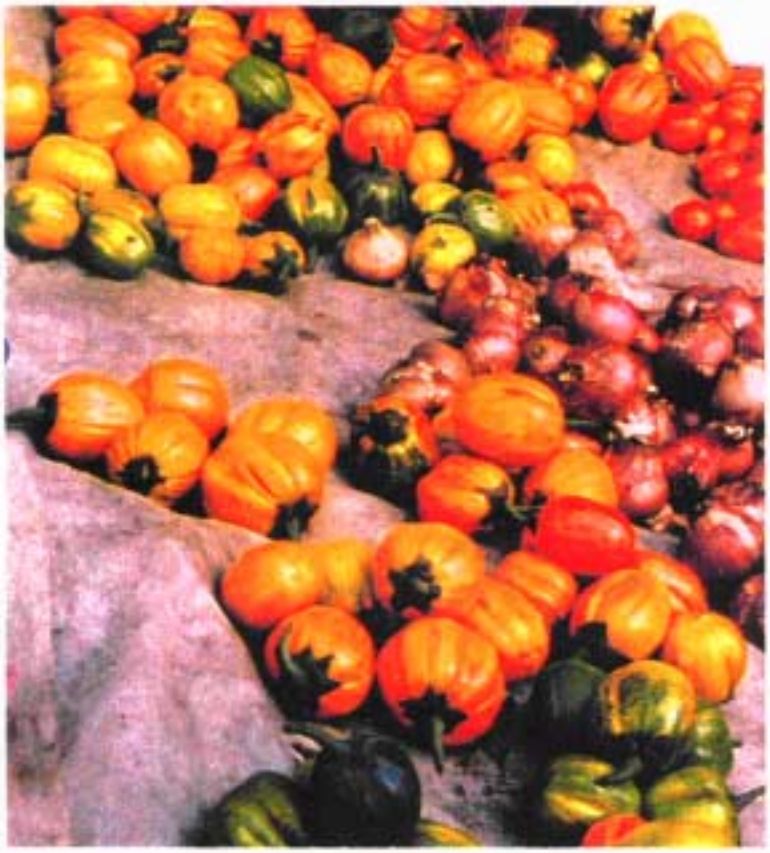
Hibiscus sabdariffa dried fruits prior to seed extraction.

Hibiscus sabdariffa
with white calyx.
(Picture A. Seck)

Hibiscus sabdariffa
with red calyx.
(Picture A. Seck)

Prof. James Chweya,
Chairman of the workshop.

Participants to the workshop
(from left to right)
J Chweya, D Ladipo, P Shiembo, J Morley, N Mnzava, (front) Ms F Nguy, (rear) B Alexis, S Bennett-Lartey, Ms M Opole, J Berinyuy, (rear) R Nono-Womdin, R Bukenya-Ziraba, A Seck, G Grubben, (front) M Besong, (rear) F Numfor, (front) Ms C Poubom, (rear) R Schippers, J Paulus, Ms G Timpo, J Ngeve, F Chigumira and Zemede Asfaw.



Garden eggs, tomatoes and onions at Faco market.

Garden eggs ready for seed extraction. Brong Ahafo, Ghana.

Sun drying cowpea leaves.
(Picture F. Numfor)

Drying sliced okra.
(Picture F. Numfor)

Young Bitterleaf cutting growing amongst Amaranths.

Leaves of *solanum macrocarpon*, *Gnetum* and Guinea peppers,
Faco Market, Cameroon.

Dr. David Ladipo collecting *Vernonia* germplasm.

Flowering Bitterleaf.

SEED PRODUCTION AND STORAGE OF INDIGENOUS VEGETABLES

Abdoulaye Seck
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INTRODUCTION

New varieties selected by breeders are first tested at different levels through yield and performance trials prior to their inclusion in a seed production system. The sequence is plant breeding, followed by variety maintenance and finally, commercial seed production.

Seed production has both qualitative and quantitative objectives. In tropical areas, the climate is often a major handicap to producing high quality seed.

The seed production procedures will vary considerably between the species and kinds of varieties multiplied. The present paper is relevant to seed production of;

- African eggplants *(Solanum aethiopicum and S. macrocarpon)*,
- West african okra *(Abelmoschus caillei)*, and
- Roselle *(Hibiscus sabdariffa)*.

It attempts to briefly review the guidelines on how to obtain good quality seed and good yields.

CONSTRAINTS TO SEED PRODUCTION IN THE TROPICS.

Until now, African indigenous vegetables have received little attention in terms of plant breeding and seed production. Good quality seed is therefore not or hardly available so growers have to produce their own seed which is not always reliable and germination is often poor. Local varieties are usually heterogenous and no selection or maintenance breeding has taken place.

Among the main constraints are development costs, low training of staff, financial resources problems, climatic conditions and unwillingness of farmers to pay a fair price for improved varieties. Due their influence on the seed metabolic activity and senescence high relative humidities and temperatures are the major constraints to obtaining disease free seeds. Accordingly, the location to be chosen for processing and storage should take the climate component into account, giving preference to a cool location with a low humidity.

BREEDING FINDINGS AND VARIETY TYPES.

At present, very little is known about most African vegetables. In Senegal, research work started about 15 years ago on indigenous vegetables (more recently for private companies) and has resulted in securing valuable genetic material and a gain in knowledge.

The genetic material involves two major groups:

- **Hybrids** which are so far not common for indigenous vegetables. First results are seen with intra- and inter-specific F1s for okra (*Abelmoschus caillei* and *A. esculentus*) and African eggplants (*Solanum aethiopicum* and *S. macrocarpon*) ;
- **Open Pollinated (OP)** varieties, the most common type, of which many stable lines and commercial varieties are available for the species mentioned above including Roselle.

In addition to information on varieties, further information on these plants is available such as floral biology, inheritance of useful attributes, yield components, cultural practices, etc.

Table 1 Breeding Findings of Some Indigenous Fruit Vegetables.

Species	Breeding findings	Obtained by		Observations
		Public	Private	
Okra *(Abelmoschus caillei)*	Several genotypes selected as SVS or crossing parent. Intra- and inter-specific hybrids are found.		x	West african type ; grows with the exotic type (*A. esculentus)*
Scarlet eggplant *(Solanum aethiopicum)*	Several OP cultivars obtained from selfing or pedigree Several F1 combinations	x	x	Many crosses carried out between ssp *Kumba, Gilo* and *aculeatum*
Gboma eggplant *(S. macrocarpon)*	A few white and green varieties, local and introdiced	x	x	Resistant to mites
Sorrel	Several red and green varieties	x	x	A breeding programme is going on in Senegal (evaluation, crossing and floral biology studies).

SEED PRODUCTION OF AFRICAN INDIGENOUS VEGETABLES.

Seed production stages

The main aim of a seed programme is to produce sufficient quantities of high quality seed. Quality linked with seed yields depends on species, varieties, acreages and growing conditions. Quality is generally assessed by several criteria such as germination rate, genetic purity, vigor, seed borne diseases, etc.

Genetic purity can be lost on account of many factors such as admixtures, cross pollination and genetic changes. Accordingly, adequate care must be taken during the multiplication process. There are four different categories recognized at international level;

- **Breeders Seed** These are small quantities of seed with a 100 % varietal purity, obtained by the breeder or under his strict supervision. It is produced from a nucleus seed stock.
- **Foundation Seed** is obtained from breeder seeds and maintained according to the system's organization either by the plant breeder or in liaison with him.
- **Registered Seed** (not always necessary) are seeds produced or maintained by a registered and trained grower in order to obtain larger seed quantities for species with low a multiplication ratio (e.g. beans).
- **Certified Seed (or Standard or Commercial Seed)** is produced from either foundation or registered seed. In places where a seed cerification authority controls a country's seed programme, it is normally certified by that agency. In other countries the seed quality is the responsibility of the seed company or the grower who supplied the farmers. In most African countries, seed certification is not common because of lack of seed legislation.

Mode of pollination and flower biology.

hand pollinated, unless other specific mechanisms such as male sterility are used. OP varieties do not need any artificial intervention and pollination is achieved through insects (bees, flies, etc) or other agents and Seed is the result of ovule fertilization after pollination. Hybrid vegetable seeds are most often facilitated by different environmental or genetic factors. Two types of plants can be distinguished in sexually propagated species;

- Self-pollinated species (pollination and stigma receptivity occur before anthesis), and
- Cross-pollinated plants (pollen is transported by insects, wind or other factors).

In addition, many other differences may exist between vegetable species in terms of floral biology (see table2).

Table 2 Floral Biology

Species	Flower morphology	Pollination		Pollen viability	Stigma receptivity	Other peculiarities
		Mode	% of cross pollination	A= anthesis		
Scarlet eggplant: Kumba, Shum and Gilo groups,	Solitary flowers or inflorescence in cyme or cluster; free white petals; anther with short filament, and porricide dehiscence	Partially self-pollinated	20-40 % Kumba, Shum > 40% Gilo, Aculeatum	A + 1 day	A-1 day to A +1 day	All flowers of inflorescence are fertile Embryo dormancy is common
Gboma eggplant	Big solitary flowers or cymes; petals white to purple; anther with short filament; porricide dehiscence	Partially self-pollinated	20-40 %	A + 1 day	A+1 day to A -1 day	Clustered fruits scarce
Okra	Solitary flower style surrounded by stamen tube; anther with short filament	Partially self-pollinated	10-40 %	A + 1 day	A + 0 day	No embryo dormancy
Roselle	Axillary and solitary flower; epicalyx with 10 bracteoles (different shapes according to botanical varieties, 5 yellow petals with red spots at base)	Highly self-pollinated	< 0,3 %	A + 0 day	A -1 day	Short stamen tube Tender edible calyx for var. *sabdariffa* unlike var. *altissima*

Sowing and cultural practices.

Compared with market gardening, more attention should be paid to the choice of the seed production plot. Land preparation is an important step in obtaining a good plant growth. Isolation is also needed to avoid either unwanted cross pollination or an unwanted spread of diseases.

Tables 3A and 3B give a summary of seed production and pest and disease control.

Table 3A Agronomy in Commercial Seed Production

Species	Sowing time (1)	Isolation distance	Seed rate per hectare	Plant Density	Fertilizer application N-P-K
Scarlet eggplant	All year long; optimum : Nov-Feb.	200 m	200 gr.	20,000 to 27,000pl/ha	150-150-200
Gboma eggplant	All year long optimum: Nov-Feb.	200 m	150 g	20,000 to 27,000pl/ha	150-150-200
Okra	April-June	400 m	4-6 kg	27,000 to 40 000 pl/ha	100-55-120
Roselle	July-August	270 m	3-5 kg	20,000 to 30,000 pl/ha	100-100-200

Table 3B Plant Protection

Species	Major pests	Control	Pathogens F = fungi, B = bacteriaV = virus	Control
Scarlet eggplant	Worms Mites Jassids Nematodes	Acephate Dicofol Acephate Cultural DD	*Stemphyllium solani (*)* *Leveillula (F) taurica* *Pseudomonas (B)*	Iprodione Sulphur Cultural Resistance
Gboma	Worms Nematodes	Acephate Cultural, DD	*Stemphylium solani (F)(*)* *Pseudomonas (B)*	Iprodione Cultural Resistance
Okra	Worms Jassids *Pachnoda sp* Nematodes	Acephate Acephate Cultural Genetic , Chemical	*Oïdium abelmoschus* *Cercospora abelmoschus* *Fusarium oxysporum(*)* (fsp Vasinfectum) YVMV (V) (2) OMV (V) (2)	Sulphur Maneb Cutural Resistance Chemical for Vectors
Roselle	Worms Jassids Nematods	Acephate Acephate Cultural, Chemical	*Oïdium abelmoschus* *Cercospora abelmoschus* *Fusarium oxysporum* *Glosporium sp*	Sulphur Maneb Cultural Maneb

(*) Seed borne disease.

(1) Sowing is direct for okra and roselle but eggplants undergo a nursery stage. Sowing is done in seed boxes and transplanting in small tubes, filled with a potting mixture including compost. This allows us to save valuable seeds (especially breeders'seed and foundation seed) and protects seedlings. The root system is less disturbed when using polythene tubes when compared with direct planting, thus creating a more uniform crop.

(2) YVMV - Yellow veinal mosaic virus; OMV - Okra mosaic virus. Both are common in Ivory Coast and the humid tropics in general.

Trueness to type and roguing procedures, varietal maintenance.

Seeds obtained after multiplication from a breeder or foundation seed nucleus is likely to give identical plants to those from that nucleus. Roguing is aimed at improving purity. It consists of pulling out off-types and plants which are infected by seed-borne pathogens. Infected weeds and cross compatible plants in the neighbourhood are removed. It is advised to start early in the morning, before the plants begin to wilt, not to inspect too wide an area at once, and to remove all undesirable plants.

Roguing should be carried out at least three times and at precise stages of the plant development, generally corresponding to full vegetative development just before flowering, full flowering stage and the fruit formation stage.

Table 4 Roguing Procedures in Relation to Plant Development Stages.

Species	Roguing stages	Plant attributes to be considered
Scarlet eggplant	Vegetative stage	Leaf shape and colour, plant height and plant erectness, leaf and stem hairiness, prickliness.
	Full Flowering	Days to flowering, flower colour, spininess and size, inflorescence type.
	Fruit formation	Fruit shape and colour, average fruit production per plant.
Gboma	Vegetative stage	Leaf shape and dimensions, plant height, leaf and stem prickliness.
	Full Flowering	Days to flowering, inflorescence, flower colour, stem colour.
	Fruit formation	Fruit colour, shape and size.
West African okra	Vegetative stage	Plant height, leaf blade shape, leaf and stem colour, average branch number.
	Full Flowering	Flower colour, bracteole length and persistance.
	Fruit formation	Fruit dimensions, shape, colour, pubescence, optimum harvest stage after anthesis, seed characteristics.
Roselle *(H. sabdariffa) var. sabdariffa (1)*	Vegetative stage	Leaf lobe number, colour, hairiness, stem colour.
	Full Flowering	Flower colour, bracteole length and shape.
	Fruit formation	Fruit shape and size, seed characteristics.

(1) This species involves several botanical varieties. In this paper, the edible var. *Vabdariffa* is referred to. In addition, attention should be paid to spontaneous wild species.

Harvest and post harvest.

Best results are obtained when fruits or pods are harvested at full maturity. Seed yields depend on various factors including the multiplication capacity of thevariety concerned, climate and cultural practices. The seed multiplication capacity is expressed as the final clean seed weight obtained divided by the seed weight used.

Table 5 : Harvest procedures and seed yields

Species	Days to first harvest (after sowing)	Total crop duration (days)	Fruit or pod yield (ton/ha)	Seed multiplication ratio	Seed yields (kg/ha)
Scarlet eggplant	115-120	160-170	20-35	1 : 1, 000-2,000	200-400
Gboma	115-120	160-170	25-40	1 : 1,300-3,000	200-450
Okra	75-90	105-120	15-40	1 : 100-150	500-600
Roselle	70-100	120-150	20-40	1 : 100-200	400-600

Seed extraction is done differently according to species and cultivars. Wet extraction is done for berries like those of scarlet eggplant and gboma. This operation is usually done by hand with a knife. Dry extraction is carried out for the dried pods or capsules of okra and sorrel. Separation can be completed after extraction and a first drying. Drying can be achieved by spreading the seeds in a thin layer on the open floor or sheet.

Table 6 Indicative seed standards for okra and eggplants

Species	Germination			Moisture Content % Maximum	Off-types (field)	Plants affected by seedborne diseases	Purity %
	1st count (2)	Last count (2)	Minimum standard %				
Okra (1)	5	10	65	9	0.5 %	0 %	98
Eggplants	8	15	70	8	0.2 %	0 %	98

(1) These standards could probability be applied to roselle *(H. sabdariffa)*.
(2) No. of days after sowing.

Seed treatment

Well dried seeds give little opportunity to pests and pathogens to spoil them. The treatment protects seeds by destroying insect pests and seed-borne fungi, bacteria and viruses (which survive on the seed coat or within the seed). Fungicide treatment is useful, but is not as efficient for seed protection as is a low moisture content. Thiram and Benomyl are commonly used fungicides. Insecticide treatment can be carried out with Lindane, Captan and Carbaryl. For some seed-borne viruses chlorhydric acid and sodium phosphate can be used.

Packaging

Seeds can be stored in cloth bags prior to packaging. One simple way of packaging is to use heat sealed polyethylene bags with a label indicating harvest date and other details.

Seed storage

Temperature and relative humidity are the major factors to be taken into account for a good seed storage; the lower they are, the slower is the loss in seed viability.

PARTICIPATORY RESEARCH APPROACHES: COMMUNITY INVOLVEMENT IN RESEARCH .

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COMMUNITY VALUES FOR PARTICIPATORY RESEARCH

No society escapes its past in looking for a future. Each societies' foundation is based upon a process determined primarily by changes in the material and immaterial environment. A review of the situation in Kenya today, as elsewhere in Africa, shows that most local communities depend upon their local environment which is value based for meeting their basic needs based upon their cultural systems and resources. Homogenous communities tend to retain societal values particularly those closest to the preservation of their culture. This closeness has thus helped retain common societal values and visions.

In the area of plant genetic resources and conservation, the proximity of people to their natural environment has helped foster the maintenance of the diversity of crops they depend upon. The process of maintenance of biodiversity within their local environment in itself constituted to local peoples development. Such processes were part and parcel of their food security and hence a right to survival. Development, coupled with rural urban migration within this century has resulted in a mixed society in which some communities are borrowing value systems from others. This has resulted in both the enrichment as well as dilution of the cultural context of some communities with resultant changing the values of material and intellectual resources, which has effected the decision making processes of some local communities.

When reviewed from the context of their being a resource base, indigenous vegetables reflect the culture and food habits of a particular community. They are both ecologically and culturally specific. Their valuation by rural communities is based upon a history of time tested trials of production, processing and consumption, within a complex system of decision making processes.

DECISION MAKING PROCESSES

In traditional or homogenous societies and communities, leadership selection was either based upon observation of leadership qualities at 'Barazas' or from effective management of domestic issue from the household to the family level. The family as a unit was envisaged as the core of the decision making processes within the community comprising of the clan or tribe. Among many rural communities, traditional leadership and decision making are still in operation, particularly amongst those communities who have had minimal contact with external influences of modernization and colonization. This is evident amongst the pastoral societies in Kenya such as the Turkana, Ormas and Masai.

Recent reviews of decision making processes show that the disruption of traditional social order has resulted in the need to develop or allow for the evolution of a new order of leadership to facilitate the sustainable and meaningful management of today's biodiversity from and within the cultural context of a people faced with the pressures of modernization. Communities living in Kenya's high potential agricultural zones and in the urban centers are continuing to loose their traditional values of governance and resource management. In this changing scenario it is difficult to enact traditional norms of decision making and management of the environment as the values are continuously changing.

COMMUNITIES AND RESEARCH

In sustaining the environment within which they live, communities living within and around areas of high diversity of plants have over years managed to find innovative ways of utilizing and sustaining their environment. Communities like other societies elsewhere are continuously experimenting with techniques of survival. Some of those techniques are quite innovative themselves contributing to the general wellbeing not only of the individual who experiments but to the community as a whole. Farmer strategies may differ from project strategies. Community agriculture strategies show that crop farming, hunting and fishing have their own specific periods in which labor peaks occur.

Labor bottlenecks are most felt at specific months. A factor with important implications for the planning of development intervention in agriculture. Project designers tend not to take this vital point into consideration. Many programmes for farmers develop from an assessment of optimal weather conditions for planting around the period in the seasonal calendars, before temperatures and humidity reach levels where fungal problems become more prevalent. Generally, most vegetables planted at the peak of the rainy season tend to run into production difficulties of pests and diseases. Local farmers are fully aware of these weather problems and have developed strategic and preventive steps. They start their land preparation for the minor season just before the heavy rains to allow transplanting to climax in June in Western Kenya.

The farmers give preference to work on their own plots during the beginning of the minor rainy season. Two factors influence them: 1) the need for farmers to make sure they have sufficient staple food crops to carry their families through the dry season to the end of the next major season and 2) the timing of planting on rain fed plots is a more crucial constraint than on irrigated plots. Hence farmers first work on their own plots, where water is a limiting factor, before they turn their attention to irrigated plots, where water is not a limiting factor.

Rural communities are continuously experimenting with techniques of survival. Some of those techniques are quite innovative themselves contributing to the general wellbeing not only of the individual who experiments but to the community as a whole. From time immemorial, different communities have evolved systems of managing their local resources in their own unique ways in some forms of experimentation. These experiments have become time tested and therefore valid specific systems. In many communities these time tested norms have become what is currently referred to as culture, indigenous knowledge or civilization of that community or people. Whereas local knowledge is based on a specific geographical and cultural context, the scientific knowledge of for instance agriculture is embedded in a value system aimed at universatility.

EXPERIMENTATION WITH NATURE

One fact of nature is that there are no systems which get rooted without a cultural base. Indigenous cultures were complete in themselves because they thrived from a natural balance. Every member of the community had roles to play and responsibilities to shoulder. They were, however, guided by very specific and strict norms which were derived from the routines of nature and what it offered normally within the locality. Farming knowledge arises from careful observation of the natural environment and its reaction to the farmer. The dynamics of experimentation, innovation and problem diagnosis are intimately connected with the processes of labor. This results in a holistic approach which is concerned with synergism and the inter relationship of the energy cycles within the farm environment, rather than the isolation of single characteristics such as yield.

COMMUNITIES AND RESEARCH

Today, African villages and their inhabitants give the wrong impression that they probably did not grow out of stable systems, yet remnants of their systems indicate that they had a sustainable livelihood which linked their basic ways of life (culture) to the locally available natural resources (ecology). Communities evolved disciplines continually and at the pace which allowed nature to remain in balance. For example, the Mijikenda and other coastal people of Kenya had a code of behavior which guided their interaction with the Kaya (shrines) which were rich in flora and fauna. Trees in the Kaya were not cut at all. In the many Kaya forest catchments, spring water, fruits and other forest products were abundant. The forests were reservoirs of wealth to be utilized by the current as well as later generations of the community. Presently, they are among the few invaluable indigenous forests in Kenya.

LEVELS OF COMMUNITY RESEARCH

Community research is part of the culture and way of life of a people. It is dynamic, yet capable of coping with changing environments. The process of farmer experimentation originated from that farmers world outlook and religious sensitiveness are important factors contributing to models of procedures and experimentation. This can be used tounderstand the integrated relationship between spirituality, nature and agriculture among small farmers. This integrated relationship is reflected in the position of the soothsayer who combines a role as intermediary with the spiritual world alongside functions in health and agriculture. For the small farmer, the spiritual dimensions are consequent upon worldly actions and are reflected in the treatment of nature in the process of gaining a livelihood and cultivating food. Spiritual manifestations impact on the relationship between people and nature and on the technique of agriculture. Within traditional societies experimentation occurs both at the material as well as the immaterial level in which the cosmovision of the community is embedded upon. Community research therefore exists at three levels: the individual level, the village level and at the community level.

The Individual Level

The religious world influences processes of farmer experimentation. In addition to curiosity, problem solving and adaptation experiments, farmers also engage in social or peer pressure experimentation. Farmers' cosmo-visions are a powerful driving force for such experimentation requires that certain varieties must be planted each year despite undesirable production qualities, and that each year they must be planted differently from the previous year, as indicated by the household head, the local priest or the soothsayer. Farmers monitor their neighbors experiments, and those who repeat the same experiments are considered to be poor farmers who will be sanctioned with poor harvests by the ancestors.

The individual level of community research starts at the family level for planning, decision making, research and information. The family is the smallest important social unit in any given society or culture. At times a family unit in the traditional society consisted of many households. This depended upon the number of wives a man had. In some cultures, each wife had her own household of which she was the head. The head of the family household(s) exercised absolute authority over their 'family' members to include sons even long after they were married and had children of their own. Before the onset of the farming season households compare the present problems they have identified against their past experiences, and formulate hypothesis which will guide their experimentation. The family head is responsible for decision making on how much land should be devoted to food production which is usually determined by the number of his household.

The Village level

Family heads over the age of forty normally belonged to some form of village leadership or council. In many villages the decision making processes which determine levels of experimentation in food and agriculture are still operational. These informal research and planning systems, using the Kamba situation as a case study, are those involving agricultural practices such as seed selection, rainnmaking rituals, sacrificial rites or 'thembo' which existed in the thirties but which in some locations are still practiced to date. For example before planting in some parts of Kitui, the oracle is consulted and a sign is awaited, sacrifices are made before planting can take place otherwise crop failure and famine are feared to befall a community.

Informal planning systems at the village may also exist at the household and family level particularly those pertaining to labor availability, household food security and the protection against wars of aggression and identification and supply of water and fodder sites. Village research in times of need for new sources of resources such as water may convene a 'nzama' to decide on how to alleviate and manage either its water shortage or an impending famine.

Design: This includes consultation with the family and soothsayers and determines the siting and lay out of the experimental plot, the factors to observe and the indicators to be measured for determining success or failure. Since problems have been discussed with other farmers from the problem identification phase, farmers are aware of the experiments being carried out by others and make inputs into their design. As a result farmers integrate their experimentation with those of their neighbors and utilize the results of others in evaluation. This results in a process of experimentation which has the feature of replicated multilocation trials under different management regimes. Experiences are shared during the cropping season and at the end of the season detailed discussions are held resulting in a thorough evaluation.

Testing: This merges into the entire farm operation and the main aims are to find if the experiments fit into the cropping calendar and labor profile. Mental records are kept charting the course of the experiments. With the testing of the new varieties, experimentation is often systematic and closely monitored for evaluation. Other types of experiment reflect an 'adaptive rationality' which may appear to be based on trial and error, to be non-systematic and chaotic.

Validation: This process starts from the formulation of the hypothesis. Experiments are validated under different parameters including social-cultural factors. These parameters may include the quantity of seed required for sowing, labor required for cultivation, harvesting and transportation, the ability of the crop to provide an all year round source of food, quantity of harvest, taste of crop and sensitivity to the growing environment. Experimentation is also interactive and iterative and in the course of testing, the hypothesis may change. Hypothesis development does not follow the strictures associated with formal science.

Evaluation and Utilization of Results: In Ghana analysis and utilization of results are simultaneous processes which start very early in experimentation, unlike in formal science where they occur at the end of experimentation. Small farmer experimentation is highly flexible and in the process of testing farmers may begin to process and utilize results, observing neighbors' experiments and using some aspects immediately. Nevertheless, an end of season evaluation of the outcome of experimentation is essential. This is carried out in different social units, including the conjugal unit and with other members of the household, with neighbors or friends who have other members of the household, with neighbors or friends who have integrated their experimentation through joining consultation, and with other members of the village in conversation at the end of the season.

At the beginning of the new farming season, farmers often discuss and analyze the results of the previous year's experiments in order to map out the use of the results. The inherent differences encountered in the process of experimentation between science and farmers are significant for the process of technology development. Recognition should be given to functional and institutional overlaps and the findings, results and experimental design are all carried out simultaneously.

The Role of Gender in Community Research

The classification of women as a labor force has been viewed statistically along the lines of industrialized countries who chose to consider women as subsistence producers in a national labor force. The other alternative for developing nations was to consider women as household heads. Taking the latter alternative perspective which is the true reflection of the role of women in Kenya, women within traditional cultural norms of practice, formulate a major labor force and take part in decision making at the crucial stage of the family level, particularly where it relates to food security. They also take part in decision making, research and sharing of experiences in family health, nutrition and family planning, agriculture; seed selection, planting, weeding, harvesting and storage and sale of small farm produces such as chickens, eggs, vegetables and fruits.

Women and children work solely on their private plots and refuse to assist the men in working on their plots. Children constitute about 50 per cent of the potential labor force per family in many farming communities. They make significant labor contributions to most crops. Women's responsibility in feeding children results in their control over child labor, since the provision of lunch can take place around their economic activities either at the market or on the farm. Children thus usually work with their mothers and follow them wherever they go. If experimental projects are to attract farmers' wives to work on project plots with greater incentive then the women would in many instances release the labor of their children to work on such projects thus constituting a process of learning for children.

Constraints to community experimentation with nature

The major constraint for farmers to engage in experimental activities include poverty, the lack of developed economic and social infrastructure, a depressed artisanal sector and lack of access to scientific and technical support. Even the most talented of researchers would be frustrated and unproductive working under such marginal conditions. New approaches to research are needed to overcome these constraints. These need to go beyond the goals in existing researcher-led programs of promoting farmer participation for the fine-tuning of research centre technologies so that they are taken up by farmers. The co-option of farmers into on-farm testing of research station technologies may serve to undermine their independent traditions of experimentation.

The task of fine-tuning technology of general relevance to a wide variety of environment may also be beyond the scope of the formal research system but is within the scope of small-scale research development institutions such as NGO's. An alternative approach is to view the whole process of experimentation as fundamental to agriculture systems, as an essential part of the farmers' craft. Farming communities do not constitute consumers of agriculture technology but are a resource community involved in research at the micro-level of the locality within which they live. Given that much remains unknown in existing scientific knowledge of tropical environments, particularly on the interaction of species within their boundaries, a top-down approach to regenerative technologies is misplaced. An interactive approach embedded within a spirit of discovery and enquiry in collaboration with local people and a recognition of the validity of local environmental knowledge is relevant and timely in development research.

There is need to develop alternative methodologies for agriculture technology development which integrate extension into the research and thus incooperate farmers perspectives. This could be done by allowing farmers to process technology through indigenous systems of ancestral worship, or through developing technologies in situ with them initially at the small scale level. To develop a synergetic interaction between both traditions of research, the performance of extension and research would be enhanced by the use of a dialogical approach which enables farmers, extension farmers, agricultural extensionists and researchers to analyze problems jointly within the farmers' environment, so as to incorporate farmer views into consideration.

Extension staff need to be reorientated towards participating in farmers' programmes and understanding the importance of rural people's knowledge and cosmovisions. Experimenting farmers can be a resource for agricultural technology development, with researchers and extensionists as catalysts. This would facilitate the exchange of information, enable farmers to understand the process and content of formal science, and help researchers to gain understanding of the procedures of farmers.

CONCLUSION

In conclusion, community participation in research within the present context of modern science is minimal from the perspective of their organization at the village level.

Communities do conduct research which is relevant to their needs, visions and social values. Such research is done within the framework of the cultural domain which itself is quite complex and eco-culturally specific.

Factors affecting equal/mutual participation of communities in modern scientific agriculture are based upon the history of the leadership organization and decision making at the village level in plant genetic resources which involves both men and women.

TRADITIONAL VEGETABLES AS A STRATEGIC FOOD RESERVE DURING PERIODS OF FOOD SCARCITY IN SOUTHERN AFRICA

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INTRODUCTION

The rainfall season in Southern Africa is monomodal, falling between November and April in normal years. However rainfall amounts and timing vary from country to country and within each country. Botswana and Namibia are the most arid, while in Zambia, Zimbabwe and central South Africa, rainfall decreases from north to south and from east to west. Most areas of Malawi, Swaziland and the Natal province of South Africa receive reliable rainfall.

In Southern Africa the majority of people dwell in rural areas where they make a living from agricultural activities. In Zimbabwe for example, where more than 75% of the country's 12 million people rely on rains to grow various crops, about 90% of that population are found in arid regions.

Due to the long history of foreign domination in Southern Africa, food and eating habits of the African people have changed significantly. Lots of exotic vegetables are now grown, including cabbages, rape, carrots, onion and tomatoes. These exotic vegetables are eaten by the more affluent people but traditional vegetables are eaten by the less well off and rural poor (FAO 1990, Mnzava unpublished, Madisa and Tshamekang 1995, and van der Heever 1995).

In urban areas poor families consume the traditional vegetables grown in their backyard gardens but the number of vegetables grown is less than in rural areas. Production of most exotic vegetables takes place during periods of low temperatures and when water for irrigation is available in dambos (wetlands) from May to August. During the rainy season exotic vegetables are difficult to produce due to high incidence of diseases.

Traditional vegetables can be found throughout Southern Africa and many rural communities depend on them. Knowledge of cultivated traditional vegetables enables farmers to grow a variety of different vegetables at different times in order to provide them with a relish throughout the year.

COMMON TRADITIONAL VEGETABLES IN SOUTHERN AFRICA

Traditional vegetables are defined here as those vegetables which were known and used by our grandparents and great-grandparents. Whether they originally came from Africa or from other continents is thus not considered.

- ***Cucurbitaceae*** family like pumpkins and squashes (*Cucurbita pepo, Cucurbita moschata, Cucurbita maxima*), various forms of watermelons (*Citrullus lanatus*), cucumbers (*Cucumis metuliferus*), etc. which are grown for their leaves, flowers, fruits and seeds.

- ***Brassica* species** like *Brassica carinata* and *Brassica juncea*. These are mainly used as a leafy vegetable

- Different varieties of **okra** (*Abelmoschus esculentus*) of which the leaves and fruits are utilised.

- **Cowpeas** (*Vigna unguiculata*) are one of the crops which are both quite popular and common as a vegetable and have several other uses. Some of the cowpea varieties provide leaves for vegetables very early and late in the season.

- **Tuber crops** like cassava (*Manihot esculentus*), sweet-potatoes (*Ipomea batatus*) and taro (*Colocasia esculenta*) are also produced, both for the roots/tubers and for their leaves.

- There is also an abundant selection of **semi-cultivated and wild traditional vegetables** from which rural families obtain relish. These are *Cleome gynandra* and *Cleome monophylla*, *Corchorus aestuans*, *Corchorus tridens*, *Corchorus olitorius*, *Amaranth* species, black nightshade (*Solanum nigrum)*, black jack (*Bidens pilosa*) *Chenopodium album* and many others. Some of these traditional vegetables are wild or found as weeds on farms or even tree leaves which are consumed only in times of serious food shortages.

PRESERVATION OF TRADITIONAL VEGETABLES FOR FOOD SECURITY.

In many of these countries both exotic and traditional vegetables are available in the fields, gardens and at the market. Marketing of fresh traditional vegetables in urban centres is now common in Zambia, Tanzania and Malawi and to a limited extent in Botswana and Zimbabwe. Marketing of dried traditional leafy vegetables has not been reported except from Botswana.

In Southern Africa, the period from August to December is the most critical to rural communities. This is the hot dry period when water for irrigation is not available in many areas. Rural farmers who have access to gardens in dambos (wetland) run out of water for irrigation. The water table usually declines to its lowest levels and wells run dry (Chigumira, Nenguwo and Jackson 1994). Food in general and vegetables in particular are scarce at that time. This is what Mnzava terms the "relish gap". Most rural communities in Southern Africa depend on preserved and stored food reserves.

Since there is no electricity and no transport in remote rural areas in Southern Africa, the only way that vegetables and other food crops are preserved is by sun or air drying. This is a common practice in rural communities of the whole of Southern Africa. This may or may not be cooked before dying. The dried vegetables are usually packed in clay pots, baskets or bags which are then stored in granaries. It has been observed that cooking destroys vitamin C and folic acid whereas vitamin A is not affected by drying but is reduced during storage (FAO 1988).

Amongst the commonly dried traditional leafy vegetables are pumpkin leaves, *Brassica carinata* and *B. juncea*, cowpea leaves, *Cleome* spp, *Amaranth* spp and *Corchorus* spp. Okra fruit can be dried whole, cut into small pieces or ground into a powder. In Zimbabwe, dried vegetables are called *mufushwa* which simply means preserved by drying. In Botswana dried vegetables are called *murongo, which* was found to be popular in both rural and urban areas.

Dried vegetables can last for more than a year but the quality and flavour deteriorates with time. Dried traditional vegetables are stored until fresh sources can be found again. This means that even in drought years, dried vegetables act as food security for rural families.

In Zimbabwe fruit vegetables like pumpkins are stored in fresh form and are used to make porridge during the dry period known as *nhopi*. The seeds of pumpkins can be roasted and eaten. After pounding, the product is moulded into small balls which are added to vegetables as a mixture. Pumpkin seeds have a high protein (26-30)%) and fat (40-50 %) content.

Cowpeas are preserved dry and are utilised in various forms; the dry seeds can be cooked, consumed alone or mixed with maize grain, and in ground form they can be prepared into a thick soup or added as powder to enrich the relish. These peas are rich in protein, vitamin B, calcium,

phosphorus and iron. The cooked leaves which are more nutritious than the cooked seed, are high in calcium (7 times), iron (3 times), very high in pro vitamin A and vitamin C, zinc, phosphorus and folic acid. The immature pods are as rich as dried cowpeas (FAO 1988).

In Zimbabwe sweet potatoes are generally preserved in fresh form. A pit about a meter deep, narrow at the top but wider at the bottom is opened up. Wood ashes are spread on the walls of the pit to discourage insect pests. The tubers stored in this way are reported to last up to the next rainy season while still remaining palatable (Gata et al 1991).

Cassava and taro can also be preserved by drying and are grown in certain regions by particular ethnic groups in Southern Africa.

Wild edible mushrooms are plentiful in Southern Africa and are usually found during the rainy season. They are gathered from the wild, eaten fresh or are dried for use later in the dry season. Mushrooms are known to be good sources of vitamins. Marketing is usually along road sides and open market places. Not much research work is currently being done to find ways of producing and domesticating wild mushrooms, despite their popularity. There is a need to treat them as a serious crop that can be used to diversify production and generate wealth in rural areas.

The contribution of traditional vegetables to the nutrition of marginalised families in remote rural areas has not been fully documented. Statistics on the amounts preserved per household for use in the dry periods does not seem to be available.

The postharvest handling during preservation and storage to maintain high quality product does not seem to have been studied. Only in Botswana is there a report of an NGO working with rural people who dry and pack traditional vegetables. The NGO facilitates marketing of the packed traditional vegetables in both urban and rural areas and they found them to be very popular in both areas (Madisa et al 1995).

Traditional vegetables play an important role as source of relish at the beginning of the wet season when food reserves are at their lowest. It is the period when most of them are engaged in farming activities.

The contribution of traditional vegetables during periods of drought is vital. Dried vegetables play a very important role to the rural poor during such periods.

CHALLENGES TO THE FORMAL SECTOR

- There is need to do postharvest studies to identify the best ways of preparing traditional vegetables before drying so as to maintain high quality in terms of food value and flavour.
- Methods of drying need to be studied and improved upon.
- Packaging and storage of traditional vegetables needs to be improved and improved techniques promoted.
- Promotion and marketing fresh and dried forms of traditional vegetables in rural and urban centres to generate additional income for small scale producers.
- Research in preservation of tubers like sweet potatoes, cassava and taro so that they last longer.
- Researchers and other interested parties should carry out studies on edible wild mushrooms and bring them in line with the ongoing research on traditional leafy vegetables. With the changes in the natural environment brought about by the ever increasing pressure on land, many of these are threatened by extinction. Most wild mushrooms are associated with natural

flora in particular habitats e.g. anthills and Miombo woodlands (Savanna type of vegetation). In dried form mushrooms maintain quality and flavour for long periods.

- In Southern Africa meals are often simple and monotonous. Nutritionists need to study food preparation methods and to publish popular recipes. This will bring more variety to the diet and will make better use of the abundant range of traditional vegetables in both fresh and dried form as is done in Asian countries.
- The role of women needs to be recognised, since they are the custodians of the knowledge of traditional vegetables production, utilisation and preservation.

CONCLUSION

Traditional vegetables have several advantages:

- They are early to come into production after receiving little rainfall.
- Traditional vegetables have been reported to be high in vitamin A, vitamin C, calcium and iron.
- Malnutrition is common for both children and adults of poor families in urban and rural communities in Southern African countries. Balanced diets at household level will improve the quality of life for many children and adults. There is a need at policy level to seriously consider incorporating (dried) traditional vegetables in food security strategies.

The role of both fresh and dried traditional vegetables has not been fully exploited to enhance human resource development in Southern Africa. More and more people are being marginalised by the persistent droughts and economic hardships. Food quantity and quality is linked to income. Peoples' incomes are influenced by the national economic performances and government policies. Southern African governments need to recognise traditional vegetables by formulating agricultural policies which assists in guiding research, production, processing and utilisation of these very important crops.

UGANDA'S INDIGENOUS VEGETABLES WITH PARTICULAR REFERENCE TO POST-HARVEST ISSUES

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INTRODUCTION

Rapid growth in food production since 1986 has returned the country to food self-sufficiency and brought about a broad-based increase in rural incomes (World Bank, 1993). Liberalization of cash crop marketing and export was aimed at stimulating production of "traditional food and cash crops" and diversifying agricultural exports.

The government policy on agricultural production and rural development includes three main objectives which are to

a) meet the country's food requirements
b) generate foreign exchange and
c) improve rural people's living standards

The above objectives do not specifically include the growth and promotion of indigenous vegetables.

The value of traditional food plants has been overshadowed by the economic attractions of other food and non-food crops. Traditional crops are those which in the past used to be our main food and cash crops, and in rural areas they are still an important part of the diet. Present government priorities in food crop production have largely resulted in the promotion of the major cereals. Indigenous food plants have always been regarded by the government as "minor" crops and not much attention has been paid to them.

Scientists have considered that access by farmers to modern inputs such as improved livestock, new crop varieties, fertilizers, pest control measures, credit and improved farm management practices were the essential components of a successful strategy to develop agriculture and meet food production goals. Consequently, traditional food plants have been poorly exploited for nutritional purposes (Maunda, 1993). In Uganda some of the traditional vegetables are used only in a small part of the country, yet they have the potential for much wider use.

Exotic vegetable species have received a lot more attention than indigenous species in terms of use and management. This is considered to be a threat to food security since true food security lies in diversity (FAO 1996).

Throughout the world at least 75,000 plant species are believed to be edible, yet we depend on just a few species as our major sources of food. More than 90% of the world's nutritial needs are provided by a mere 30 plant species and only about 150 species are commercially cultivated. The human plant food base is thus very narrow and does not offer adequate food security.

People are aware that there are numerous local fruits and vegetables as well as other types of local staple crops which are already adapted to local habitats, are cheap and easy to grow and are acknowledged to be highly nutritious. These crops should therefore be promoted if true food security is to be achieved. People throughout the tropics have depended on their

indigenous plants for food security. A variety of foods is needed to supplement the cereal staples in order to provide a nutritionally balanced diet.

In Uganda the number of indigenous vegetable species is far greater than the exotic ones. However, a large number of them are not regularly cultivated but grow as "weeds" in the field. There are a number of crops which produce large quantities of dark green leaves or edible seeds or fruits and these crops are used to improve the flavour and are incorporated in sauces. Women pick these from the wild or grow them in home gardens from where they harvest and prepare them for cooking or dry them for future use. People in rural areas still know very well which plants are best suited for a particular use (Goode, 1989).

Despite the importance of indigenous vegetables to rural communities, extension workers and nutritionists have mostly ignored the role played by our local crops and have excluded them from their food surveys. There is thus a need to develop a national food policy that should be broad-based, encouraging the use of a wide range of food sources which are readily available to the people.

There are however some constraints as well as opportunities regarding the growth and use of local vegetables, including;

- The main production is during the rainy season when there is an over-supply of both leafy and fruity vegetables. During the dry season there is a shortage during which previously dried and conserved vegetables could be consumed.
- Some vegetables such as leaves of the cocoyam *Colocasia esculenta* could be stored for up to two years. For most other vegetables however, this period is much shorter and commodities may be spoilt during this period. Much valuable food is lost through damage by insects, rats, mice and other vermin but also as a result of the high humidity which encourages growth of fungi and bacteria.

Further research is needed to utilise this opportunity and to look into ways of improved storage. Research is also required to investigate how we could best process the excess of fruits and vegetables produced during the rainy season, particularly by using low-cost methods, including sun drying and packing in containers.

ETHIOPIAN TRADITIONAL VEGETABLES: SYNOPSIS OF SITUATION AND DESIRABLE STEPS AHEAD

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THE ROLE OF TRADITIONAL VEGETABLES IN ETHIOPIA

Amongst the cultivated and non-cultivated plants of Ethiopia, there are a large number of species that are used as a vegetable. These rarely form the main dish but are more frequently used as side dishes, minor additives and sometimes vegetables are grown to generate an income for the family.

People produce their own seeds and seedlings in homegardens. It is a good place for perennial crops which are protected by well built fences. There are minimal post harvest losses in home gardens as crop products are mostly harvested when there is a need for them. Crop remnants are plowed in while others are given to domestic animals and the remainder is left to be recycled by nature to enrich the soil.

In a recent study made on homegardens in southern Ethiopia, it was found that vegetables make an important part of the traditional crop mix. This is more so in rural than in urban homegardens. Urban homegardens in the area appear to be shifting towards growing fruits because of their marketability. This trend may ultimately undermine enhanced vegetable cultivation in homegardens.

Homegardens are the best places for maintenance and evolution of traditional vegetables. The indigenous farmers' know-how has to be used and promoted. Conservation of traditonal vegetables could be ensured by growing them in homegardens and on farms.

The tradition of fasting by a major group of the society adds to the significance of vegetables as they are frequently used on fasting days.

Many species of vegetables are cultivated around the homestead and some weedy species of vegetables are tolerated to flourish to produce seeds. Other species of vegetables are those that are occasionally collected and used from among the wild flora. The consumption of non-cultivated vegetables increases during periods of drought when there is a shortage of grain, especially at the end of a growing season. Vegetables become important foods during such periods to fill the food deficit gap and are thus regarded asstrategic reserve foods.

Indigenous vegetables are becoming more common in the diets Ethiopians and their cultivation has increased in line with their popularity. This has increased their market value. Urban centres are becoming more important markets for vegetables, including indigenous vegetables such as Ethiopian kale. The traditional vegetables are not sold in modern vegetable stores but rather in traditional market places, on roadsides and around churches, especially on celebration days. They can also be found at street corners, serving the low income groups of people. They are more regularly and abundantly available in markets during fasting periods and on special fasting days of the non-fasting period.

The use of traditional vegetables has been handicapped by a number of constraints. If some of these constraints could be removed it would contribute to a more optimal use of Ethiopia's

genetic resources. The different categories of vegetables have different constraints and these have to be addressed separately.

SOME TRADITIONAL ETHIOPIAN VEGETABLES

While Ethiopia has some species that have been cultivated for decades in homegardens and other premises, there are many more which are found and collected from the wild vegetation. A third category are those on the borderline between cultivation and the wild. These usually cultivated vegetables are also found growing as "weeds"on field margins and other places. Some species are considered to be of high potential as food crops.

Cultivated Vegetables

Traditionally cultivated vegetables include the following;

Abelmoschus esculentus(F)
Allium alibile(R)
Amorphophalus abyssinicus(R)
Arisaema schimperianum(R)
Brassica carinata (L&S)
Brassica nigra (L)
Cajanus cajan(F)
Coccinia abyssinica(R&L)
Colocasia spp.(R)
Dioscorea spp.(R)
Ensete ventricosum (R/S)
Moringa stenopetala(L)
Plectranthus edulis (R & ?L)
Sphenostylis stenocarpa
Vigna unguiculata(F&L)

(R=root, S=shoot, L=leaf, F=fruit)

The leaves of some cultivated crops are sometimes used as leafy vegetables such as the leaves of pumpkin and sweet potato.

Borderline Vegetables

The following species are in the process of being accepted as cultivated vegetables;

Solanum nigrum (L),
Urtica simensis (L/S) and
Cyperus bulbosus (R)

Wild Vegetables

The list below includes vegetables which are mainly collected from the wild;

Amaranthus spp.
Commelina latifolia(R)
Dioscorea quartiniana
Dioscorea schimperiana(R)
Eriosema cordifolium(R)
Eriosema shirense(R)
Girardinia diversifolia
Luffa cylindrica
Momordica foetida
Rumex abyssinicus
Rumex nervosus
Cayratia ibuensis
Bauhinia purpurea
Corchorus olitorius
Corchorus tridens
Diplolophium abyssinicus
Eruca sativa
Cissus adenocaulis (R)
Hypoxis obtusa(R)
Hypoxis villosa
Pterocarpus lucens
Sisymbrium irio
Sisymbrium officinale
Campanula edulis (R)
Cyphia glandulosa(R)
Cyphostema adenocaule
Embelia schimperi
Erucastrum arabicum
Erucastrum abyssinica
Launaea taraxifolia
Portulaca oleracea
Portulaca quadrifolia
Vicia hirsuta
Vicia sativa
Vicia villosa

The effort made to use and further domesticate the vegetables that were being eaten by distant ancestors, as seen in especially West African countries, has not yet started in Ethiopia.

SOME CONSTRAINTS TO OPTIMAL USE OF VEGETABLES

Most vegetable crops are produced during the rainy season. The extended dry season is devoid of vegetables, in particular the leafy vegetables. Since most families in rural parts produce vegetables during the rainy season, they do not get markets for their surplus, leading to wastage. There are no established methods of keeping leafy vegetables for a longer period after the harvest. Drying and storing leafy vegetables for use at a later date, as is the practice in southern Africa, is not done either.

During the dry season only a few families produce vegetables by supplementary irrigation. When possible these products are transported to the cities where they can fetch a good price. However, this transport is often not available or arrives late. Sometimes the leafy products wilt and dry before they reach the market place. Some vendors are seen throwing away the products when they find that the leaves have become limp and no customers are interested in them.

Attempts to domesticate additional crops are hardly made. Black night shade (*Solanum nigrum*) is left in homegardens for use of its leaves, though it grows as a weed, in southern Ethiopia.

Traditional vegetables do not have proper research attention. Consequently their production and use is limited. While research on the cultivated vegetable crops is very minor, non-cultivated vegetables have not even been properly surveyed or inventorised. Research ought to get a higher priority in both categories to improve their yield capacity and quality, thereby raising farm income and improving the nutritional status of the people. Further research is also needed on processing and their storability.

Traditional homegardens where traditional vegetables abound do not receive enough attention and their cropping system is poorly understood by the scientific sector. They represent a rich source of knowledge which needs to be tapped.

The trend towards growing more fruit trees in home gardens as obsereved in some urban areas in southern Ethiopia requires careful attention from a nutritional point of view. Since the economic drive is likely to keep on moving in the direction of more fruit trees, research must be conducted to find out vegetable species that thrive underneath the fruit trees.

DESIRABLE STEPS AHEAD

Whereas traditional vegetables are very good sources of food and provide essential nutritional value, particularly by supplying vitamins and minerals, they are neglected by modern agriculture. They should be given proper attention in many respects. These steps include:

- Find and designate a responsible institution to be concerned with traditional vegetables and work towards minimum capacity building.
- Study of the ethnobotany and indigenous knowledge of traditional vegetables, both cultivated and non-cultivated.
- Technology transfer for drying, preserving and reducing post-harvest losses. Much can be learnt from other sub-saharan African countries in this regard.This includes agronomic studies to develop farming methods that do not necessarily require additional land for traditional vegetables.

- Study the agrobotany of selected non-cultivated traditional vegetables with the hope of including in cultivation some of the more promising ones.
- Study consumer attidudes towards traditional vegetables in both urban and rural communities in order to develop a strategy for their promotion.
- Study the nutritional values and toxicity levels of non-cultivated promising vegetables.
- Study problems associated with the use of traditional vegetables i.e.

  -Post harvest problems and means of alleviating them
  -Means to ensure the continuous supply and inclusion of vegetables in the peoples' diet.

Preparing ensete (false banana) products is a very laborious and often difficult task for women. There are some attempts to introduce implements to assist the processing in some parts, but these are rather experimental at present. Other vegetable products could also be processed and used in a better way. Studies should focus on the means for improvement of such vegetables.

Indigenous means of combating post harvest problems of vegetables should be studied and enhanced. For example, root and tuber crops are left in the soil until needed to minimize post harvest losses, other products are wrapped in banana/ensete leaves and wetted dry leaf sheaths of the same, the use of wet fresh plants for keeping the moisture, especially of green vegetables, pumpkins are traditionally buried in deep (dug) pits to keep them fresh for a long time.

Some of the above issues are being addressed but mainly on a very small scale.
Concerted efforts are required by agricultural research institutes, gene banks and NGOs.
While individual researchers can concentrate more on basic aspects of research, more applied and farmer oriented studies can be undertaken by research institutes and NGOs since they have a structural organization that will allow them to reach grassroots farmer groups, through involvement in farmer-based participatory researches and development activities.

REPORTS OF THE WORKING GROUPS

WORKING GROUP 1 (Rapporteur Dr R Bukenya-Ziraba)

Theme

Ethnobotany and indigenous knowledge, nutritional assessments, electronic data bases, published and grey literature, collections and dissemination strategies, priorities for germplasm collection and storage, cross border exchanges.

Presentations

Dr Zemede Asfaw

In Ethiopia indigenous vegetables are grouped into three major categories;

a) non-cultivated, e.g. *Amaranthus, Corchorus* etc.
b) cultivated such as *Brassica carinata*
c) border-line cases such as *Solanum nigrum*.

Constraints regarding growth of indigenous vegetables include;

a) seasonal variation in their availability
b) post-harvest handling not or poorly developed
c) poor domestication efforts so far
d) no serious research and promotion of ethno-botany. Indigenous knowledge, traditional ways of drying, their merits and demerits need to be studied. Research should be at universities, at grassroot level, involving all people and NGO's.

Dr Bennett Lartey gave a summary of his proposal on an intended project to further promote the use of leaves of *Xanthosoma* and *Colocasia* as a vegetable. The objectives of the study are to collect and characterise germplasm, start a selection and improvement programme and further promote its utilisation.

The study is justified because young leaves are a staple crop in Ghana and elsewhere in West Africa, the crop has an economic potential, it requires only simple cultivation techniques, its yields are high and is of high nutritive value. There is a need to select cultivars which are suited to the different ecological niches, whereby tests will be carried out both on station and on-farm. There is a further need for guidelines for farmers and extension material in general.

Dr Bukenya-Ziraba reported on the situation in Uganda with regards to indigenous vegetables and especially post-harvest issues. Constraints were similar to those reported by Dr Zemede Asfaw. Other problems encountered were that government officials and scientists alike regard indigenous vegetables as minor crops. Only a limited number of exotic vegetables are promoted and become a threat to traditional crops and thus to food security. Farmers are not willing to set aside enough land for cultivation of local vegetables which leads to their disappearance altogether. Limited shelf-life and damage during transportation are the main post-harvest issues. Also marketing of indigenous vegetables has not received adequate attention.

Possibilities for further action in Uganda include;

- drying of vegetables, using locally developed techniques (people at grassroot level and NGO's should participate).
- household research to establish which crops are liked and why,
- market surveys to quantify supplies at different times of the year,
- nutritional and toxicological studies,
- transportability, storage, crop presentation, processing possibilities etc.,

- cultivation and other agronomic trials.

Discussion

After these three presentations, the group agreed that there is a need to carry out household and market surveys, and to study home gardens. Methods used should be standardised throughout the country and the region.

Research should concentrate on a limited group of indigenous vegetables. The following crops were selected;

Solanum nigrum (complex), *Corchorus spp, Vernonia spp, Amaranthus spp'Hibiscus spp, Xanthosoma/Colocasia*

It was suggested that for the key species identified, descriptor lists ought to be prepared.

The choice for regions should be based on demand for the product so that priority will also depend on the assessment of genetic erosion and documentation on indigenous knowledge, including appropriate technology on preservation methods.

Participation by local communities is important in evaluating germplasm, its nutritional value, possibilities for food preparation, including recipes. Other stakeholders such as seed firms, marketing agents and others should also participate.

Further research is required in breeding for which private initiatives are most welcome. The related taxonomic research will need to be done by public institutes. Agronomic research should get a high priority.

For non-domesticated crops such as *Gnetum spp* there is a need for conservation and an integrated (regional) approach is required to carry out case studies in;

a) *Ex-situ* conservation seed research, establishment of seed banks at country level

b) *In-situ* conservation, protection of species whereby the community should participate in the re-introduction of disappearing species.

c) Domestication efforts to relieve pressure on natural populations. Farmers should be encouraged to visit trial farms to see possibilities to produce new crops in their own farm.

SUMMARY

- There is a need for further ethno-botanical studies including recipes
- Networking: CORAF, ASARECA and SACCAR to play a role in the formation of a formal network on African vegetables. Exchange of information from Francophone and Anglophone countries through translations or otherwise through the network
- Establishing a central database. Investigate who could do this and how it could be funded - Kew, IPGRI, NRI, CTA? Bibliographies and compilation of grey literature. Listing national information. Make abstracts available through the network.
- PROSEA activities to be extended to Africa in the form of Plant Resources for Africa. Funding? Partners?
- Species monographs to be produced for selected key species.

Studies on home gardens to be made more accessible, e.g. UN Univeristy.

WORKING GROUP 2 (rapporteur: David Ladipo)

Theme

Species priorities, varietal evaluation, genetic enhancement, seed production, marketing and consumption, post-harvest treatments and processing.

After full consideration of the various presentations in these areas, the group concluded that the following areas and activities are highlighted under the subjects to be considered.

Species Priorities

To prioritize vegetable species, the group considered that researchers consider the following operations, that is determination of;

- Demand situation for each of the vegetable species
- Seasonality, (annual or perennial)
- Geographic distribution of species
- Status of domestication and potential for marketing and consumption of the vegetable species within their areas of production and use.

Based on the above considerations, the group chose the following species as priority species for Sub-Saharan Africa (collectively), West, East and Southern Africa individually. Species selected include:

Sub-Saharan Africa	**West Africa**	**Central Africa**	**East Africa**	**Southern Africa**
Amaranthus	*Vernonia* spp	*Amaranthus*	*Gynandropsis*	*Amaranthus*
Garden eggs	*Corchorus*	Garden eggs	*Amaranthus*	*Hibiscus sabdarifa*
Hibiscus sabdariffa	*Celosia* spp	*Hibiscus sabdariffa*	Garden eggs	*Corchorus*
Corchorus	W Afr. Okra	*Corchorus*	*Solanum americanum*	*Brassica carinata*
Solanum americanum	*Xanthosoma Colocasia*	*Gnetum* spp	*Corchorus*	*Gynandropsis*

Varietal Evaluation

We need to look at the available variabilities already recorded or identified on each of these priority species. Substantial variation can be observed within a single accession, probably caused by its high level of outcrossing. This variation is shown in plant height, fruit shape and colour, vein colouration, earlines etc.

Genetic Enhancement

Before this takes place work on taxonomic issues and breeding systems should be carried out.

It is vital to consider the breeding issues in the light of farmer and consumer perspectives

As seed is poorly viable, improvement and dissemination of material will mainly be through clonal selections.

Seed Production

The need was expressed to carry out a survey to know the availability of seeds -improved or otherwise- in various localities throughout Africa. The immediate need is to make preliminary selections from our land races to be tested both on-station and on-farm in a participatory way, involving farmers and scientists alike.

Private initiatives at community level should be encouraged to generate information on production techniques, harvest criteria, packaging and transportation requirements.

Education through extension will help in wider acceptability of indigenous vegetables, aiding future development efforts.

Marketing and Consumption

It was considered vital that an Africa-wide market survey be conducted at an early stage. This study should include seasonality and effects on availability of other produce at that time.

Post-Harvest Treatment and Processing

Indigenous methods are already available but these need to be validated and improved.

Shelf life

There are also steps to be taken to prolong shelf-life.

Studies on the maintenance of the nutrient qualities of vegetables concerned is important.

Processing

Further post-harvest studies including vegetable drying etc. need to be done

Research Needs

We need to develop guidelines for production including advisory leaflets on each crop for farmers. Particular aspects relating to harvest time and post-harvest quality, need to be put in view i.e. IPM, crop nutrient need, cropping systems research, cultural practices and harvesting methods.

WORKING GROUP 3 (rapporteur Fabeon Chigumira)

Theme

Participatory research approaches

Definition

Participatory research means that from the beginning the clients, in this case the farming community at grassroot level, extensionists, consumers and other persons concerned with the production and use of traditonal vegetables, will be actively involved in all aspects of the process of research and development, i.e. technical, socio-economical, and cultural.

Role of public and private institutions

A strong interaction is needed between researchers, farmers, NGO's and extensionists. NGO's, donors and private seed companies should become more pro-active in searching for opportunities for cooperation with the public sector.

Public research institutions should carry out strategic and applied research needed for the development of traditional vegetables, such as germplasm evaluation, breeding for yield, quality and resistances, and cultural practices. Research should be carried out on-farms as well as on research stations.

Community development and extension to enhance indigenous knowledge is a first responsibility of the private sector.

The local seed supply system should be studied and private initiatives encouraged and supported by the public sector. Applied breeding and seed production should be left to the private sector as much as possible. Community seed banks may be of interest.

Gender

In promoting indigenous vegetables we should be sensitive to the fact that in most aspects women are strongly involved as custodians of indigenous knowledge. Research teams consisting of technicians, sociologists, anthropologists etc must be balanced in gender.

Farming systems

Production of traditional vegetables for home consumption, of great importance for food security, is practised in labour- and input-extensive mixed cropping production systems and in the more labour-intensive home gardening system. Both production systems are also involved in market production and there is a gradual transition to the contrasting system i.e. the input- and labour-intensive market gardening.

Research is needed concerning crop rotation, influence of shade, drought-tolerant species, crop mixtures to avoid pests and diseases, etc.

Intensive market gardening is characterized by high labour requirements and often high external inputs such as fertilizers, pesticides and where available, seed. Mono-cropping can be frequent, especially for exotic crops. Special forms of intensive market gardening are urban and peri-urban market gardening. Here we see mostly leafy vegetables which don't tolerate long transport. In peri-urban market gardening, traditional vegetables are often mixed with exotic types.

Income generation

Market gardening of traditional vegetables is very labour-intensive. Research data on costs and returns are needed. The public and private sector should support small enterprises in production and marketing. Simple management training e.g. bookkeeping, can be given to small entrepreneurs at grassroot level. Research and training in post-harvest handling, packaging, marketing, conservation etc.is needed.

Food strategies for survival

There is a need to quantify the potential effects of increased supply of traditional vegetables and especially of the leafy types, being the most nutritionous species, on the national human health situation. Avoidance of malnutrition such as blindness caused by vitamin-A deficiency or anaemia caused by iron deficiency or the consumption of a species such as *Psophocarpus*, which stimulates a mother's milk production, do have a large impact on the health of the total population.

Diversity in traditional vegetables should be promoted and genetic erosion should be overcome to prevent hunger and improve food security. Promotion of home gardening should be a national policy, including components related to cooking, processing, and preservation.

RECOMMENDATIONS FOR FOLLOW-UP ACTIONS

At the final day of the workshop, after the working groups presented their findings, a summary of ideas for future action was made as follows:

1 **Assembling grey literature in each country**, collation and analysis and where possible, preparation of extracts. Material to be sent to IPGRI and to be added to the data base held by Dr Mnzava. Other arrangements could be to expand the economic botany data bank at Kew.

2 **Establish a newsletter** and if possible a network with a secretariat. For the network, CORAF, ASARECA and SACCAR will be approached. NRI was asked to see if funding could be found for the newsletter. Further contacts considered were the tropical crops action group within ISHS but also AVRDC and IPGRI.

3 To lobby for a **PROSEA-like project which will document Africa's crops**. Monographs are required for key vegetable species such as *Vernonia*, Garden Egg, *Hibiscus sabdariffa*, *Corchorus spp* and *Solanum nigrum*. Action: IPGRI and CPRO

4 **Surveys** are urgently required for

- Market demand and supply during both rainy and dry seasons. Action: NRI
- Needs assessment for the seeds sector. Action: CPRO, possibly with NRI

Other surveys would be appreciated which include nutritional assessments of both fresh and prepared indigenous vegetables, surveys on genetic erosion and on conservation. Action: For the latter, funding would be looked for by IPGRI

5 **Utilisation of germplasm** has a high priority. Where possible, private initiatives to be encouraged. Authorities, including apex organisations, to be approached to relocate research funding from exotic crops to indigenous crops. Priority areas are;

- genetic studies and initial breeding programmes leading to seed supplies
- agronomic research leading to production guidelines
- post-harvest research
- extension and promotion of traditional vegetables.

6 Urgent steps to be taken to replace collection of ***Gnetum spp*** from the wild and to initiate a domestication programme before this crop is lost from Cameroon. Weekly exports from Cameroon to Nigeria of over 300 tons cannot last. The significant local consumption will need to come from cultivation and not from the wild. Action: Project proposal to be drafted by Dr Shiembo, jointly with IPGRI and others.

7 **Co-ordination**

All proposals will be sent to the 3 organisers and to apex organisations for follow-up activities.

Proposals for activities in West and Central Africa to be prepared by IITA together with Dr Ladipo and IPGRI. Proposals for further activities in East and Southern Africa will be prepared by Dr Mnzava, AVRDC, Ms Opole and IPGRI.

PRIORITY CROPS FOR FURTHER RESEARCH

a) Crops which are important throughout the region

1. *Amaranthus* spp
2. Garden egg (*Solanum aethiopicum* and *S. macrocarpon*)
3. *Solanum americanum/nigrum* complex
4. *Corchorus* spp.
5. *Hibiscus sabdariffa*

b) Crops important to West and Central Africa

1. *Vernonia* spp.
2. West African Okra
3. *Colocasia/Xanthosoma* leaves
4. *Celosia* spp.
5. *Talinum triangulare*

c) Crops of importance to East Africa

1. *Brassica carinata*
2. *Gynandropsis gynandra* (also Southern and Central Africa)
3. *Crotallaria* spp.

d) Crops of interest to Central Africa

1. *Gnetum* spp., especially for Cameroon, Gabon, Zaire and also Nigeria.
2. *Psophocarpus scandens*, the African winged bean, especially for Zaire.

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ANNEXE

DOMESTICATION OF INDIGENOUS VEGETABLES FOR SUB-SAHARAN AFRICA: A STRATEGY PAPER

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EXECUTIVE SUMMARY

Studies made for the Cities Cash Cropping Project indicated that indigenous vegetables play a highly significant role in food security of the under-privileged in both urban and rural settings. However, it was found that little is known about them and that many local vegetables found in sub-Saharan Africa are not or hardly domesticated.

Especially in West Africa, farmers grow a wide range of crops such as egusi melon, fluted gourd, Lagos spinach, bitter leaf, garden eggs and others which are highly important locally but virtually unknown outside this region. Such crops dominate local markets whereas a further wide range of indigenous vegetables can be found in home gardens and on small-scale production plots, to be used either at home or for sale in neighbourhood markets.

Interviews held with farmers, home gardeners and extension officers, revealed that the main constraints facing the farming community is the lack of information on such crops. In most cases there is no accessible literature available to refer to and there are certainly no crop production guidelines covering these crops. Also, the poor availability of seeds and the lack of choice in varieties were frequently mentioned in addition to more common problems such as inadequate water and the need to control pests and diseases.

The present study was undertaken in Ghana, Kenya, Nigeria and Tanzania from where the 25 most important crops have been listed and a summary is given of information available from either local sources or literature. It was noticed that a lot of information is available on ethno-botanical issues whereby many local crops were used both for medicinal use and as a vegetable. What is far less researched are basic agronomic issues such as differentiating a number of varieties, identify the best planting distance, cultivation techniques and post-harvest issues.

Accordingly a strategy was proposed which covers:

- Collecting data in electronic form and exchange of information between researchers
- Study germplasm with a view to select varieties, followed by dissemination of seeds.
- Conduct basic agronomic trials to result in guidelines for the farming community.
- Carry out a survey of market acceptability for selected crops

Finally, a suggestion is made to arrange a workshop for selected scientists and policy makers from sub-Saharan Africa to validate the present paper and to devise a strategy towards increased utilization of indigenous vegetables, followed by a plan of action. Such an action plan should be geared towards decision makers and researchers in target countries, thereby indicating a possible role for potential donors through bilateral or multilateral programmes.

INTRODUCTION

Many people living in sub-Saharan Africa see vegetables as an important source of nutrients in their diet and either grow their own vegetables or go to the market to buy cabbages, tomatoes, onions and similar crops. Such vegetables are often the only ones they know and most people are hardly aware of the fact that there are also many different species of local African vegetables which have up till recent times been a main source of food security to their community.

There is a wealth of local African crops, often of highly nutritive value, waiting to be exploited. Such crops can contribute to diversity in present farming systems and could be modified to meet the expectations and specific demands from people living in agro-ecological zones ranging from semi-arid to humid. However, the strategic value of the many indigenous vegetables and their potential within the formal agricultural system have not been extensively studied.

The opportunity to make use of these valuable genetic resources may be diminishing rapidly not only because of competition from introduced crops but also due to erosion of their natural environment and failure to adequately record their characteristics and usages. A further important reason for action at an early date is that the gap in acceptance between tasty exotic and perceived less tasty local vegetables may become too wide, especially when support for local crops from elderly people, who still know them today, will no longer be there.

Accordingly, the need was expressed to formulate a strategy for the conservation and utilisation of indigenous crops and for recording relevant local knowledge. A short study was carried out from the end of April till the end of July 1996 with the purpose and research activities as below.

STUDY PURPOSE AND RESEARCH ACTIVITIES

The study will develop a strategy for opportunities in research in indigenous vegetables. This will make reference to on-going research and the potential for collaboration with other institutions and collaborators in target countries.
The activities are as follows:

a) Identify people and institutes working on indigenous vegetables used in Ghana, Kenya, Nigeria, Tanzania and Zimbabwe as well as people and institutes of other sub-Saharan African countries who could contribute to an exchange of information and germplasm through a proposed network.

b) List the more important amongst the indigenous vegetable crops used in each country and make an effort to prioritise crops and research needs. Out of these lists, create a new short-list of potential crops used in several target countries which are of commercial or nutritional interest to most countries involved.

c) Collect available information on these crops through a literature review or otherwise. This should include their relative importance, cultivation techniques, known constraints including pests and diseases, their ethno botanical value (e.g. medicinal use, cultural or gender bias, home garden use, etc), known germplasm collections and varietal diversity, occurrence in the wild and information on the close relatives, etc.

d) Investigate involvement of the donor community in this sector especially with regard to present activities and new initiatives under consideration.

e) Discuss with representatives of institutes and research stations involved with indigenous vegetables such as IPGRI in Nairobi, the Institute for Alternative Crops in Southampton, staff from Kew in London, Birmingham University and other centres such as Wageningen where germplasm collections are held and where relevant information could be obtained.

f) Assess the value of indigenous vegetables as perceived by farmers in a representative community and draw on information from other projects e.g. the Cities Cash Cropping Project in Enugu, Nigeria, and the Integrated Food Crop Systems Project in Ghana.

OBSERVATIONS MADE

Results from parallel studies such as the Cities Cash Cropping studies in Nigeria and the peri-urban horticulture project in Dar es Salaam, Tanzania, strongly indicate the significant role which local vegetables play in the diet of the urban poor. In these studies it became clear that the underprivileged cannot afford to buy seeds, fertilisers or other inputs and the best way to satisfy their demand for vegetables is by making use of what has been traditionally available over the years. Many such crops grow fast and produce quite well without elaborate care, which makes them even more attractive.

These studies have also indicated that women and young children benefit especially from indigenous vegetables which they collect from their own cultivated plots near their homes or from the wild or open spaces not far from their homestead. In peri-urban areas where a substantial proportion of food requirements for cities is being produced, it was noticed that most producers are middle aged or elderly people who were not successful in finding a suitable job in town.

Fertilisers are beyond the financial means of most urban producers. Fortunately however, it was found that several types of indigenous vegetables respond very well to substrates of town-generated wastes, whether well decomposed or not. Such crops include amaranths, black nightshade, spider flower, black jack and others which are frequently referred to as weeds even though they are perfectly edible. Several other crops grow well on disturbed land or roadsides, offering opportunities in new land-use systems as found in urban and peri-urban environments.

Produce from home gardens or small plots in peri-urban areas are often sold through small-scale business in the informal sector or by family members (mainly women or small girls) or a trusted member of the community. These vegetables and others collected from environments such as waste lands, are then offered at street-corner markets or small community markets where most customers belong to the low income group.

Market studies in Kakamega, Kenya and Enugu, Nigeria show that on the main markets there are a lot of exotic crops and here indigenous crops are not well represented. On the smaller markets however, and especially those in poorer urban areas or in rural areas, indigenous vegetables often play a dominant role. This is also the case in countries such as Zimbabwe where exotic crops appear to have taken over altogether. Interestingly, in major cities such as Nairobi there is now a demand for traditional crops for which a high price is being paid.

There is evidence that traditionally not much difference was made between medicines and vegetables. Many vegetables had a double function to cure all sorts of ailments. Children often preferred to eat fruits from the local vegetation whereas older people were more interested in vegetables. Ethno-botanical studies indicate that there are a wide range of vegetables prescribed by village elders or medicine men for expecting women or lactating mothers. Others are used to ease stomach ailments or to help people with diarrhoea or to ease

their stools. It may therefore not be very surprising that many local vegetables taste bitter and are rich in alkaloids whereas many others are slimy when cooked.

The wide range of local leaves, fruits or roots which were consumed, kept people fit and healthy and people recognise their nutritional values even though they are not aware of vitamins or micro-nutrients. One of its consequences is that many people do not consider vegetables as a type of food that fills their stomach such as starchy foods or meat. Vegetables are however appreciated for their taste and become an added ingredient to the staple food used.

The above shows the general difference between indigenous vegetables and exotic ones which are used by people who are generally better off. As a result of suppression of less desirable elements and enhancement of more desirable characteristics, exotic vegetables often are more sweet and soft when cooked, which is appreciated especially by the youth. In contrast, the nutritional properties of many indigenous African vegetables often surpass the value of exotic ones through their high vitamin and micro-nutrient contents.

From the above observations, the conclusion is drawn that indigenous vegetables play a very important role in feeding poor people and especially women. In most rural areas they are used as a subsistence crop. It also plays a vital role in employment opportunities, in income generation and poverty alleviation. Experience gained and small savings made in either the production or marketing process can be used to climb one or two steps on the ladder towards improvement of their livelihood through an expansion of activities beyond the basic survival strategy.

To further demonstrate the importance of indigenous crops for poor people, an example is given from Enugu in southeast Nigeria in table 1 below. It will be noticed that out of the 10 vegetables mentioned, the exotic crops tomato and pepper only rank in place 8 and 10 respectively. Pumpkins are here considered as a traditional crop even though its origin is in South America.

Table 1 Prioritised List of Fruits and Vegetables produced in and around Enugu, indicating the percentage of respondents* growing them.

Nr	Crop	Urban	Peri-Urban	Rural	Average
1	Fluted Gourd	97	98	100	98
2	Amaranth	96	100	97	97
3	Garden Egg (small Shum types)	95	87	89	90
4	Water Leaf	81	82	100	88
5	Okra	80	91	88	86
6	Pumpkin Leaves	85	86	65	78
7	Black Nightshade	62	84	88	78
8	Tomato	69	86	75	77
9	Bitter Leaf	87	75	67	76
10	Capsicum Peppers	73	86	68	74
11	Banana	51	75	44	56
12	Plantain	48	73	44	55
13	Mango	29	66	46	47
14	Guave	28	65	42	44

* The number of people interviewed in urban, peri-urban and rural areas was 73, 89 and 54 respectively, totalling 216. All respondents were either people producing crops in home-gardens or small-scale farmers.

OTHER FINDINGS

Indigenous vegetables when grown on a small scale are not usually hampered by outbreaks of pests and diseases. However, when such crops are grown as a monocrop and even more so when this is done on a large scale and over a longer time span, there is every likelihood that pests and diseases become uncontrollable. The assumption therefore that local crops are less prone to diseases is only valid when such crops are grown on a small scale and even more so when grown in mixed stands together with many other cultivated or non-cultivated species.

Fields with black nightshade in Kenya were found to attract aphids which were quite problematic during spells of drought. Similar problems were found with diseases on *Amaranthus hybridus* in West Africa where reports showed that other *Amaranthus* species were less susceptible. However, these other species were only produced on a very small scale. Lists of diseases found on indigenous vegetables in Nigeria as prepared by Mr Fajinmi from NIHORT are very long, a strong indicator that the perceived tolerance of indigenous vegetables to pests and diseases is merely an assumption.

Food security is a major theme in drought susceptible areas. Very few exotic vegetables are drought tolerant so that alternative crops will need to be used in combination with innovative types of agriculture. In these semi-arid zones people are not accustomed to the cultivation of crops since they are usually pastoralists who move with their livestock from one place to the next. Current tendencies for some of these people to setlle for longer periods, open new opportunities for new crops which are adapted to drought and heat. A number of potential crops have been identified. However, they will require detailed investigation to aid further development. Without such crops it is better to rely on perennial crops such as trees rather than on existing annual crops which may not produce anything at all when rains are inadequate or erratic

CURRENT RESEARCH IN KENYA, GHANA. NIGERIA AND TANZANIA

In the four countries visited, indigenous crops feature very low on the research agenda and funding is scarce, partly because donors have not shown much interest in these crops.

In **Kenya**, the Regional Research Centre in Kakamega has been given the national mandate to deal with indigenous vegetables. However, no funding has been made available by KARI to carry out any research on indigenous vegetables and fruits. Some research has been centred around Kisii, based on private initiatives, by side tracking funding meant to deal with soil improvement. Small-scale experiments were made to establish the best planting distance for a few varieties of black nightshade and to get more information on its response to fertilizers.

In Kenya, ethno-botanical research has been carried out jointly between the National Museums and the East African Herbarium. Long lists have been prepared indicating which crops are edible and mentioning some very interesting features. This important 3-year study was carried out in several locations throughout the country and ended by pointing out some promising crops. Unfortunately that was the end, not the beginning, of an exercise leading to domestication of new crops.

Both Nairobi University and Jomo Kenyatta University of Agriculture and Technology are now stimulating some of their students to pay attention to local crops, resulting in a few Msc and PhD thesis which were presented during the last few years, dealing with two crops: black nightshade and spider flower.

In **Ghana,** there is hardly any research carried out with horticultural crops, whether indigenous or exotic, partly caused by dominant donors supporting the Crops Research Institute who have given such a high priority to staple crops that horticultural crops have become neglected. A

recent funding facility offered by the World Bank may change this picture to some extent even though the development of indigenous crops has not been emphasized specifically. Of the main crops to be dealt with, both by the World Bank project and by ODA's Brong Ahafo project, only garden egg can be considered as indigenous in Africa. The crop okra could also partially be considered as indigenous in so far attention will be given to *Abelmoschus caillei*, the West African okra.

Universities are so far not very active in this field with one or two exceptions such as the *Corchorus* study by Dr P Y Boateng of the University of Science and Technology in Kumasi, dealing with spacing trials and fertilizers, and direct sowing compared with transplanting. Also Dr Daniel K Abbiw of the Botany Department, University of Ghana, Legon has made a contribution through his publication in 1990 'Useful Plants of Ghana'. This publication includes a section on local vegetables.

In **Nigeria** the situation is very different and the country is clearly ahead in its research. Several publications exist, listing the many different local vegetable crops but, what is more important, there are also quite a number of detailed studies on individual crops dealing with general agronomic issues as mentioned in further detail in annex 1. Each of the four agricultural universities in the country gives attention to local vegetables.

The Horticultural Research Station in Ibadan (NIHORT) gives indigenous vegetables a high research priority next to tomatoes, peppers and onions. Due to their comparatively limited distribution range however, most indigenous vegetables are of regional rather than of national importance. The station has an extensive germplasm collection and a library with many reports dealing with indigenous crops.

In **Tanzania** horticultural research takes place in either Tengeru near Arusha or at Sokoine University near Morogoro. Unfortunately, indigenous vegetables have not been given special attention in Tengeru's training programme so that its students are not fully aware of its potential. Seed production for these crops was attempted but its dissemination was found to be a weakness in the system. Also in Morogoro, most attention is given to exotic crops and not to native vegetables. Yet, there is clear evidence that indigenous crops are playing an increasingly important role in Tanzania even though one wonders what contribution researchers have played in its popularisation.

Researchers based at the two centres mentioned have made a number of proposals for funding to start research work with local crops but have not been able to get a positive response from the donor community. In an agreement between SADC countries (Zimbabwe, Zambia, Malawi, Mozambique and Tanzania), Tanzania was meant to lead in the development of indigenous vegetables. Through lack of funding this initiative did not materialise. Also, GTZ's Vegetable Network Programme in which Dr Lewis made some contributions towards identifying indigenous vegetables in Tanzania, has come to an end.

INVOLVEMENT OF DONORS

The survey carried out so far has shown that the donor community is mainly interested in supporting ethno-botanical issues, especially where gender plays a role. Accordingly, a number of publications were made possible through funding provided by FAO, DGIS and few others such as the Ford Foundation. Some research has also been carried out by GTZ, ODI, CIDA and by CIRAD but not on a large scale to my knowledge. Sweden and other nations are supporting research on indigenous fruit trees and other useful trees found in Africa. As far as I am aware, American donors from both private and public sector, are no longer actively promoting the use of local crops in either East or West Africa.

AVRDC has only limited resources in terms of staff and finances and has therefore placed a low priority on development of 'new' vegetable crops from the large pool of edible crops found around the world. Their activities in Africa with a base in Tengeru, Tanzania, concentrate on tomatoes and peppers. They have indicated on several occasions that they would like to get involved further but lack the funding to do so.

The International Plant Genetic Resources Institute (IPGRI) with headquarters in Rome and a regional office in Nairobi with a sub-station in Cotonou, Benin, is currently the most active organisation dealing with indigenous vegetables. The Netherlands have recently provided IPGRI with US $ 150,000 towards an ethno-botanical study on the biodiversity of neglected leafy green vegetable crops in Africa. This study will document indigenous knowledge and socio-economic and cultural data on plant genetic resources.

There are indications that both the European Union and IFAD may soon step in as donors to this relatively new area, which will need further investigations.

CHOICE OF CROP SPECIES

World-wide, there are about 13,000 species which are used as food by either people or livestock, out of which approximately 3000 are found in Africa. These figures are subject to interpretation and no exact figure has been quoted as to how many are used as a vegetable in sub-Saharan Africa. Of approximately 800 food plant species found in Kenya for instance only 210 species are leafy vegetables, out of which 60 have been listed as potential crops which warrant not only conservation but also promotion and further research efforts. To shorten this list even further, there are only 17 indigenous vegetable species in Kenya which are presently cultivated or are in a stage of domestication. For other countries in Africa no similar statistics could be found.

A ranking exercise was undertaken during visits made to Ghana, Kenya, Nigeria and Tanzania whereby additional information obtained from literature was used. Out of this exercise, shown under table 2 as below, mainly crops found in markets were included. Therefore, the very many species cultivated by people in their homesteads are not included and neither are those species which are collected from the wild. This list includes a total of 25 main species and are described in further detail in Annex 1 where also related species are mentioned.

The list as below is the outcome of many discussions and in my opinion specifies those crops requiring special attention. Preferably not too many species should be removed from this list because even the 'C' marked species often represent an ecological niche where this crop could play an important role. It is however clear that a domestication exercise will be very costly, especially the more advanced stages of domestication, in which also market forces will play a role. It could also be stated that every case is unique. The approach towards domestication and expected results will therefore be totally different for each species. A group approach is thus impossible. Therefore choices will have to be made once the first data collection phase has been concluded and target areas have been identified.

Table 2 covers existing and potential new crops for dry areas, a number of crops for the transition zone and savannah areas and a list of vegetables for more humid areas, currently the most important place where indigenous vegetables are grown and consumed. The ranking for which the letters A,B and C have been used, roughly corresponds with the amount of research information and grey literature available. It also appears to correspond with the degree of domestication.

Table 2 INDIGENOUS CULTIVATED VEGETABLES* OF IMPORTANCE TO PEOPLE IN GHANA, KENYA, NIGERIA AND TANZANIA

Species	Use **	Ecology ***	Ghana	Kenya	Nigeria	Tanzania
Abelmoschus caillei	f	t-s	B		B	
Amaranthus spp.	l	g-t	C	A	A	A
Asystasia spp.	l	g-t		C		C
Bidens pilosa	l	t-s		C		C
Brassica carinata	l	t-s		B		A
Celosia spp.	l	g	B		A	
Citrullus lanatus	s	t-s-a	A		A	
Colocasia esculenta	l	g	B		C	
Corchorus spp.	l	g-t	B	A	A	B
Crassocephalum rubens	l	g	C		C	
Crotalaria ochroleuca	l	t		B		
Cyphia glandulifera	l	a		C		
Digera muricata	l	g-s		C		
Gynandropsis gynandra	l	t-s		A	C	B
Hibiscus sabdariffa	f	s-a	C	C	B	
Kedrostis pseudogijef	l	s-a		C		
Sesamum radiatum	l	s-a	C	C	B	
Solanum aethiopicum	f	g-t-s	A		A	C
Solanum macrocarpon	f,l	g	B	B	A	A
Solanum americanum	l	g-t	C	A	A	B
Talinum triangulare	l	g-t	C		B	
Telfairia occidentalis	l,s	g	C		A	
Vatovaea pseudolablab	r,s	s-a		C		
Vernonia ssp	l	g-t	C	C	A	
Vigna unguiculata	l,s	g-t-s	A	A	A	A

* In this context vegetables collected from trees have been excluded.

** f = fruits or flower parts l = leaves and shoots r = roots s = seeds

*** g= Guinean belt/humid zones t= transition zone between forest and savannah
s= savannah a= arid zones

Ranking: A: very important, at least at regional level
B: at regional level ranking between 5th and 10th place
C: presently of local importance only; potential for further development

SUGGESTED STRATEGY

The domestication process for many western types of crops has resulted in preferred tastes, sizes, shapes, colour and nutritional value of many varieties found in western markets at present. What is needed is a similar domestication effort for potential crops found in sub-Saharan Africa or for that matter, any other part of the world. Such a domestication process could start by collecting available germplasm and by describing existing and known gene pools. It could also record desirable traits as expressed by different members of the community such as youth or elders, women or men, who are likely to have different views and expectations.

The donor community has so far concentrated on ethno-botanical issues and a lot of useful information has become available. What is far less documented is actual research on crop production constraints and related agronomic studies. Also post-harvest issues have so far featured very low on research agendas.

When questioning subsistence farmers about what they feel as their main constraint, they usually respond by mentioning pests and diseases and by lack of seeds for indigenous vegetables. The extension staff have expressed their concern that there are no guidelines on indigenous vegetable production and are thus not able to advise their farmers. The high perishability of most leafy vegetables was a further area on which many people were seeking advice.

Throughout sub-Saharan Africa, few species have been subject to really detailed investigation. Their nutritional value is often poorly understood even though nutrient analyses have been made for more than half of the crops listed above. Also the more negative elements or anti-nutrients such as presence of nitrites, oxalate content, etc are not fully known. There are a number of indications that this is one area requiring attention at an early stage so that varieties could be selected which are not harmful to people's health.

Based on observations so far I have come to the conclusion that there is an urgent need to:

(i) Bring together all information currently known in the fields of ethno-botany, taxonomy, geographic distribution and ecology, nutrition and medicinal properties, agronomic aspects, pests and diseases etc.

(ii) Collect germplasm from as wide and diverse an area as possible together with closely related species.

(iii) Carry out basic research on the most important crops which will deal with variety selection and purification, seed production, planting distances, pest and disease management and cultivation practices.

(iv) Carry out a survey of market acceptability of indigenous vegetables.

During the survey it was found that there is a vast amount of grey literature hidden in local libraries and in the form of Msc, PhD or similar thesis or research papers found in the many universities throughout sub-Saharan Africa and especially so in West Africa. Finding such information and re-presenting it in digital form would be of considerable help to scientists with an interest in relevant topics concerned. In addition, there is also a vast amount of information hidden in data bases held in Europe and the USA such as for instance in Kew, Missouri and Wageningen, which could be tapped when resources to do so could be made available. Francophone literature is frequently not available to anglophone students and the other way round.

It is suggested that collection and re-presentation of such data should have a first priority. An electronic data bank to be set-up at say IPGRI in Nairobi, Kenya with a duplicate set in Cotonou, Benin, could facilitate research requirements for the next stage. This next stage should ideally be a study of available information to be compiled in book form comparable to PROSEA's Plant Resources of South-East Asia and thereby listing the more important of Africa's indigenous vegetables and gene banks for specific crops. It is realised that such a combined study may take a few years to complete but it should not be too difficult when local researchers in a number of countries will become involved.

Real domestication work will start with collection of germplasm from as wide an area as possible and be made available to researchers on the basis of equal exchange of materials. One of the unfortunate consequences of the Rio conference is that many countries will no longer allow a free use of their genetic resources and instead will insist on shared use of the proceeds of research when derivative products will be marketed. This has created a lot of complications but should not necessarily be a serious bottleneck when there is a cooperative spirit amongst individual researchers.

Germplasm will then be evaluated and characterised with both desirable and undesirable traits recorded. From here selections could be made and developed into local varieties for which seeds could be specifically produced and made available to beneficiaries which include both the farming community and research colleagues.

Further domestication in the form of recombinations and crosses would be the next stage of domestication. In such a breeding process certain characters could be suppressed or eliminated and others to be more clearly expressed. Additional desirable characteristics may be introduced from related species as has been the case for tomatoes and many other well developed exotic crops. However, such breeding activities are here considered as beyond the scope of expected budgetary provisions.

As soon as agronomic data are available, either from research carried out by the project or from reliable data from grey literature, extension hand-outs will need to be prepared as part of a promotion campaign to re-popularise the use of local vegetables.
Such production guidelines will also be much appreciated by local staff from the departments of agriculture who are in great need of reference material. Further advice will be needed by farmers on correct harvest and post-harvest procedures, including packing and storage.

As part of the strategy and in order to comply with requirements of international donors such as IFAD, the European Union and others, it is here proposed to join forces with a non-U.K.-based organisation with research experience comparable to NRI. One of these could be CPRO-DLO in Wageningen, Holland and the other could be INRA or CIRAD in France.

Since the target area is sub-Saharan Africa, it is clear that researchers from several African countries will need to be involved. A suggestion has been made to involve African collaborators from the very first stages onwards, which has been done so far but also to involve them further in the decision making process. One way of doing this is to organise a **seminar** where representatives from a number of both East and West African countries should be present. A strategy could then be worked out in detail whereby crop species could be prioritised further and an agenda for action devised.

Ideally such a workshop should be organised in a country where indigenous vegetables are important and a diversity could be seen on the spot. The Cameroons have been mentioned as an ideal location to reflect interest of both francophone and anglophone scientists. In addition, the area is very important for indigenous vegetables with both lowland and highland species

represented. This suggestion will need to be worked out in further detail once agreement has been reached and funding has been made available.

The latest development in this connection is that the Dutch have have shown their interest in the proposed activities and may be willing to co-sponsor the suggested workshop on indigenous vegetables on condition that it will link up with IPGRI since they have recently funded research activities which are complementary to most of the suggestions in this paper.

APPENDIX 1 SELECTED INDIGENOUS CULTIVATED VEGETABLES FROM WEST AND EAST AFRICA

Abelmoschus caillei (Malvaceae)
The West African Okra is a bi-annual or perennial shrub which may reach 3m in height and produces fruits in the dry season, contrary to the common okra, *A. esculentus*, of South and Southeast Asian origin, which produces fruits after 3 months or less during the rainy season (or under irrigation). *A. caillei* is known mainly from the Savannah belt and less so from West Africa's humid coastal zones. There is a need to collect the rather variable germplasm from this species now before it is replaced by the more popular short season exotic types. *A. caillei* is especially liked for its ability to dry well and to retain its mucilaginous characteristics. Some varieties are also eaten for its young, tender leaves. The West African okra is far less susceptible to Okra Leaf Curl Virus than (especially exotic) varieties of the common okra. Outcrossing between the two species is rare, partly because there is only a limited overlap in the flowering periods, and hybrids are usually infertile.

Amaranthus spp. (Amaranthaceae)
A group of highly popular vegetables, belonging to many different species. A lot of work has been carried out with the Central American *A. cruentus* and *A. hypochondriacus*, which have recently been placed under *A. hybridus*. The taxonomy of these groups and the many African species, is still confused however, and further work is much needed. The *A. hybridus* group includes grain amaranths, which can be used both as a grain crop and as a leafy vegetable and these are commonly found in many places in Africa.

Amaranthus dubius, which is occasionally cultivated in Kenya, originated in southeast Asia. There are however many real African species which are much appreciated such as *A. lividus* from Western Kenya, *A. graecizans*, mainly found in somewhat drier areas and others. These species have not been given specific attention even though people prefer them because of their milder taste when compared with the often strong taste of the high yielding exotic types. There is a definite need to collect germplasm of the various African species and to analyse their nutritional and consumption properties as well as possible undesirable characteristics and from there onwards develop certain selections into a truly local crop.

There are several indicators that exotic Amaranths (and especially *A. cruentus)* are far more susceptible to pests and diseases than the local ones. Comparative trials between various African and introduced species have not been made to my knowledge. Recently, researchers at Nigeria's National Horticultural Research Institute at Ibadan have carried out a series of trials with grain amaranth to develop the necessary agronomic practices and screened varieties for disease tolerance.

Asystasia spp. (Acanthaceae)
Commonly found in throughout sub-Saharan Africa on roadsides or disturbed places nearby peoples' houses. The two species: *A. gangetica* and *A. mysorensis (= A. schimperi)* and possibly other related species as well, are used as a leaf crop towards the end of the rainy season when there are not so many other vegetables around. It is mainly collected from the wild but such weeds when found in home gardens are usually left undisturbed and are allowed to produce seeds. *Asystasia* usually does not get higher than about 40 cm but can be harvested once it is about 20 cm high. It produces many side shoots and regenerates fast, allowing several harvests as a ratoon crop. As far as I am aware, its cultivation is rather localised in western Kenya and northern Tanzania. In West Africa *A. gangetica* is a locally used vegetable, grown during the rainy season which is also used for its medicinal properties to prevent dysentery

Bidens pilosa (Compositae)
Black jack as it is commonly known, is frequently found as a troublesome weed which is difficult to eradicate. It grows very fast and people who like to eat it can harvest their first crop in about 3 weeks from sowing. In Tanzania's West Usambaras, villagers collect the crop as part of their weeding exercise but do not spare them or collect seeds for planting since it sows out so easily by itself. It is also eaten in Nigeria during periods of general food scarcity and ends up in soups. The strong flavour puts most people off. To my knowledge no varieties have been selected yet which are appealing for whatever reason. Young leaves of the related *B. bipinnata* are similarly used as a vegetable. In Nanyuki, Kenya, this species is collected for extraction of natural dyes.

Brassica carinata (Cruciferae)
The Ethiopian Kale can be found over a large part of eastern Africa and beyond at the onset of rains, especially in disturbed areas or in cultivated land as a weed. Most people in Western Kenya and Tanzania harvest it for the kitchen but only few make an effort to cultivate it. In Western Kenya it replaces the kale, generally found in cooler places, and appreciate the soft taste when compared with kale or collards which has stronger and much larger leaves.

B. carinata is claimed to be somewhat poisonous and can cause goitre but since people only eat it for a few weeks per year, harmful effects are hardly reported. For some accessions the glucosinolate content is lower than that for kale, offering scope for selection of more healthy varieties.

There is some confusion about the correct name of this species, which is especially found around Lake Victoria and could be different from the real Ethiopian kale, which is mainly used as an oil seed crop. The fact that it readily produces seed in these warm areas, which kale does not, raised interest amongst researchers in both Kenya and Tanzania, especially since the material is quite pluriform. It only takes about two months to produce seed from seed. The potential to grow this crop under irrigation exists and produce brought to markets is eagerly taken up by consumers. Further selection and research on its agronomy may be warranted.

Celosia spp. (Amaranthaceae)
Lagos spinach is a very fast growing crop, that in some places is now overtaking *Amaranth* in popularity such as in Southwest Nigeria due to its soft taste, when compared with leaves of grain amaranths. It is now also becoming more popular in Benin and in coastal Zaire. It reaches a size of up to 50 cm after about 4-5 weeks when it can be uprooted whole or alternatively, the top could be removed, allowing new side shoots to develop. If left undisturbed, seed plants can reach a size of 150cm or more.

The most common species in Nigeria is *C. argentea,* which has its origin in the coastal zone of tropical West Africa where it can be found as a weed in open, disturbed places. There are a number of varieties with broad, green leaves and one with a large red spot in its center (Red Soko) which is quite popular. The related *C. isertii (=C. laxa)*, which is less common, has distinctly narrow leaves and a third African species from savannah areas, *C. trigyna,* is the least common, probably due to its somewhat bitter leaves. Outside Nigeria, *C. argentea* is not often seen cultivated on large areas. It can be found in neighbouring West African countries, including Ghana where people are not much used to it (yet). A comprehensive overview on *Celosia argentea* has been prepared by Dr T Badra in "Williams J T :underutilized crops...', which should be refered to for further information. The closely related cockscomb, *Celosia cristata* from South Asia is a well known ornamental crop but is not usually eaten as a vegetable.

Citrullus lanatus ssp. mucosospermus (Cucurbitaceae)
Most seeds belonging to the cucumber family which are used for extraction of oil are grouped under the name **'Egusi'**, a name used throughout West Africa. By far the most common species within this group is *Citrullus lanatus*, the same species but different subspecies as the watermelon. It is a very old crop, the seeds of which are used as condiment or as a thick soup since ancient times. It is closely related with the colocynth, *C. colocynthus*, which is very bitter and even poisonous. This egusi has a long ethno-botanical history and its uses are highly diversified, ranging from the most important use of their seeds as protein rich food to varied medicinal use of the white pulp and its use of the pulp as gun powder. Extracts of the bitter peels of colocynth are used to keep camels away from water sacks. Oil extracted from seeds is used for illumination and many other uses could be mentioned. One of these is its effectiveness as a weed suppressor since it can fully cover the soil. It is therefore often used as an intercrop with maize or other tall growing crops.

Citrullus lanatus has three centres of diversity: a) the Kalahari dessert and surrounding areas where fruits are mainly used as a source of water during periods of drought
b) the southern Sahelian zones and neighbouring savannah areas where fruits are mainly used for their oil seeds and c) arid regions in southern Ukraine where much larger fruits were originally selected for their water holding capacity. There is therefore a great potential to combine some of these characters to develop larger fruits with dual purposes as a source of seed and as a source of water in arid areas. Such an effort requires a cooperation between scientists from different areas who will need to exchange germplasm for evaluation under local conditions and as a source of new genes in their breeding programmes.

In West Africa there are a large number of egusi varieties, many of which have been collected and are kept in gene banks, especially with NIHORT in Ibadan. Most of these varieties were selected for their edible seeds, which are important as a source of Vitamin E, edible oil and protein. Significant work has been carried out on its agronomy, including mechanised production as a large-scale field crop. There are now decorticators on the market so that women no longer need to spend many hours removing the seed coat before being able to roast the seeds. Cleaned seeds weigh only about 50% of seeds with a seed coat.

Other 'egusi' types found on markets in Ghana and Nigeria include *Cucumeropsis mannii (=C. edulis)*, which has smaller, longer seeds and *Lagenaria siceraria*, the bottle gourd, seeds of which are however less popular than *Citrullus* ones. It would be useful if all work on Egusi could be combined in a single publication to get a better overview of this important crop, which is hardly known outside West Africa. Further work required includes characterisation of the range of varieties, followed by a breeding programme to select varieties which are more tolerant to diseases in combination with a high yield potential

Colocasia esculenta. (Araceae)
The eddo or taro, is mainly known for its edible tubers and resembles the introduced cocoyam *Xanthosoma sagittifolia* with its sagittate leaves as opposed to the peltate leaves of *Colocasia*. In Ghana and Nigeria both tubers and leaves are eaten from crops which are mainly found in the wild and limited efforts have been made towards its cultivation. *Xanthosoma* is more popular for its leaves and can also be found in many West African countries where it is often cultivated in swampy areas or nearby rivers. A monograph on *Colocasia esculenta* has recently been written and is available through IPGRI for further reference.

Corchorus spp. (Tiliaceae)
Jute mallow is found throughout Africa, from where it originates, and is not only popular in wet regions of sub-Saharan Africa but also in dry areas e.g. Egypt where some farmers ocasionally grow the crop in greenhouses during winter months to cater for its demand. It is also popular in the Middle East and South Asia. It is a very old vegetable, which was mentioned in early Greek literature. The most commonly found *Corchorus* species in Africa, *C. olitorius*, is highly varied in size, branching or the shape of its leaves. Some forms are used for their bast fibre, similar to the white jute, *C. capsularis*, originating from South China and India/ Myanmar. There are a number of related African species, which can be used both for their fibre and as a leafy vegetable.

In Africa, *Corchorus olitorius* is used mainly for its leaves which, when cooked, form a mucilageous substance comparable to okra soup and for its immature fruits which in West Africa are referred to as 'bush okra'. Bush okra is frequently dried and ground into powder for use during the dry season.

On the market of Makurdi in Benue State, Nigeria, different varieties or species with distinctly different leaf shapes, were sold mixed together, even within the same bunch. There are many species collected from the wild or from exotic cultivated crops, including the somewhat bitter tasting *C. trilocularis* which was noticed to be used as a vegetable in Kenya. In Zimbabwe *C. asplenifolius* is mentioned to be a popular local vegetable. In savannah areas of West, East and Southern Africa, *C. tridens* is grown. Crossing between the various species was found to be difficult by researchers in Ibadan due to flower drop after emasculation. Natural crossings are however found.

Post-harvest studies have indicated that the harvested shoots could remain fresh for a few days when placed in polythene bags without diffusion holes. Research in Ghana showed that transplanting is not easy but when plants survive they produce more and stronger side shoots. Also topping of plants will give stronger side shoots but a reduced fruit and seed yield. In Ghana transplanting is recommended when fruits are aimed for since this was found to induce earlier and more abundant flowering, especially when using 23-day old plants. Nigerian researchers found that fruit production is most strongly when plants are growing under short-day conditions with 10 hours of natural daylight, followed by 14 hours of darkness. In Africa most research attention to this crop is probably given in the Sudan where it is much appreciated for their 'Malachia' soup.
A special status report for Nigeria has been prepared by Dr L Denton for *Corchorus*, which gives further details on its nutrition, agronomy and other aspects.

Crassocephalum rubens (Compositae)
Commonly found in Southwestern Nigeria where it is both collected from the wild and cultivated. It is a climbing vegetable, occuring throughout the more humid parts of West Africa. They are cultivated in well drained soil with a high proportion of organic material, usually under a tree or shrub for shade and support. Propagation is by 25 cm long cuttings, obtained from mature shoots; less frequently by using seeds. Flowering shoots are usually removed to encourage leaf production. Mulching is found to be highly beneficial. Leafy shoots are harvested approximately 60 days after planting and harvesting may continue for one year or more depending on the vigour of the plants. Leaves are mucilaginous and are usually used in soups, both in Ghana and Nigeria. It is said to have medicinal properties whereby its juice is applied to sore eyes.

Crotalaria ochroleuca (Leguminosae)
In western Kenya this crop is collected both from the wild and increasingly from cultivated land where people plant up to four times per year, compared with a maximum of twice yearly production of most exotic crops. It is planted mixed with other local vegetables and its seed is commonly available on local markets.

Crotalaria ochroleuca with its broad leaves and broad pods has a mild taste and is much appreciated by young people. This is especially so when compared with *C. brevidens* with its more narrow leaves and smaller pods, said to be more prefered by older people because of its bitter taste and also because of its medicinal properties that will help reducing the effects of stomach ailments. *Crotalaria* is usually eaten jointly with cowpeas or with pumpkin leaves and less commonly on its own.

The substitute *C. brevidens*, more commonly known under the name sunhemp, has multiple uses including those of 'green manure' and as a fiber crop (jute). As a green manure the whole crop, including its leaves, will be incorporated into the soil thereby improving both the soil structure and adding nitrogen. A recent use for *Crotalaria* is as agent to promote germination of *Striga*, the highly problematic parasitic plant which is a major cause of concern for maize growers in East Africa. When, as a result of *Crotalaria* presence, *Striga* germinates, it will subsequently die due to the lack of a suitable host plant. Accordingly, it has triple or even quadruple potential: as a control mechanism for *Striga*, as a vegetable, as green manure and as supplier of fibres.

Further research therefore appears highly warranted. To my knowledge no serious research has been carried out with respect to *Crotalaria ochroleuca* as a vegetable and therefore no agronomic or other advice can be given to farmers when they ask extension staff to do so.

Cyphia glandulifera (Lobeliaceae).
A potential crop with large succulent leaves which is commonly found and consumed in the Kitui area of Kenya. It is one of the few crops which grow well on black cotton soils. Both leaves and tubers are eaten but little is known about them apart from the fact that Kitui people consider them as a delicacy. Any research on this crop should start with collection of germplasm from as wide an area as possible and to analyse its genetic potential. The species is known from grassland or wet depressions in warm areas of Somalia, Ethiopia, Kenya and Tanzania. This species is highly variable in leaf shape and growing habit and also in taste of the tubers.

Digera muricata Amaranthaceae
This leafy vegetable, belonging to the Amarantaceae is especially popular amongst the Giriama and other coastal tribes in Kenya who cook its as a spinach. It has two distinct subspecies which are equally appreciated by people although the large leafed ssp. *patentipilosa* takes less work to collect and to prepare. It has potential for further development but since it can still be found in the wild, there is little incentive for cultivation by Giriama people although its distribution is limited to a small area along the coast. Also the Turkanas are known to eat it as a vegetable. Its full potential should be evaluated when comparisons could be made with other leafy vegetables grown in e.g. western Kenya. It is also much apreciated by livestock, including elephants. In India its seeds and flowers are used to treat urinary disorders.

Gynandropsis gynandra (Capparidaceae)
Both black nightshade and the spider flower are rapidly becoming more popular, especially in Kenya. Gynandropsis is probably more commonly grown as a vegetable in Kenya than in other parts of the world even though it has become a pan-tropical weed and vegetable of home gardens in e.g. Zimbabwe and other places. Prof. J A Chweya of University of Nairobi's Crop Science

Department, is keen to further promote this crop and he is currently preparing an overview of information available.

Saga, the local name for this crop which is called mnangani in Kiswahili, was found in all the four Kenyan markets visited: Kisii, Luanda, Kakamega and Kisumu. It was however nowhere really common and ranked fifth amongst the indigenous vegetables found in Kakamega and Kiboswa markets. Also in West Africa it is not common and only occasionally found in markets in the northwestern parts of Nigeria. It is here considered as quite tolerant to drought.

The main pest on spider flower appears to be beetle flies, which chew away at the margins of leaves, making the product less attractive for human consumption. Cooked spider flower is customarily used by Kisii women just before and again after giving birth. It is known to help against stomach ailments. It contains very high levels of calcium and iron.

Hibiscus sabdariffa (Malvaceae)
This crop is mainly known from hot and dry areas as found in northern Nigeria and the sub-Sahelian zone of neighbouring countries. It is the only vegetable known to me of which the succulent whitish green calyx is specifically selected as food. These calyxes are often dried and used in the dry season. Its leaves are nutritiously important as a source of minerals and vitamins. Leaves are finely cut and used in soups. People dry the calyxes for use when there are no green vegetables around. The red calyx of related varieties belonging to the same species are used as tea in the Sudan, in Egypt and in similarly hot Central African countries from where the species originated.

Kedrostis pseudogijef (Cucurbitaceae).
In the east and especially northeast of Kenya this species can be found on hedges and fences around houses. Its leaves and young shoots are eaten together with starchy food. The leaves are reported to have an unpleasant odour. It can be a fast growing climber which is highly drought tolerant and remains green. Cultivation is limited to sticking a piece of stem in the ground at the start of the rains. It takes root within a short time and grows vigorously during the rains. According to Patrick Maunda from the National Museum in Nairobi who compiled most of the data for the Indigenous Food Plants Programme, sponsored by the Ford Foundation, no agronomic research has been carried out with regard to this interesting home garden crop.

Sesamum radiatum (Pedaliaceae)
Sesamum radiatum can grow up to 150 cm high when most of its leaves and shoots are no longer succulent. The crop is mainly grown for its leaves and young shoots, contrary to the related *Sesamum orientale (=S. indicum)* which is grown for its oilseeds in e.g. Benue State, Nigeria. It is collected both from the wild and is also cultivated in savannah and drier areas as found in the middle belt and northern Nigeria but also in Ghana, Cameroun and other countries up to East Africa. In Africa there are approximately 25 related *Sesamum* and *Cerathoteca* species, many of which are used for their leaves or seeds and collected from the wild. It is often found as a weed nearby villages.

Leaves can have a strong odour which not everybody appreciates. Leaves become mucilageous after cooking. Recent attempts have been made to select varieties which are more suitable as a vegetable but results of this programme are not known.
Apparently this species has been in cultivation since ancient times and appears to be on the decline as a leaf crop.

Solanum aethiopicum (Solanaceae)
A crop which has been around for a long time, given its considerable varietal diversity and its distribution over the greater part of Africa. The present species results from a domestication

process with *Solanum anguivi* as its wild ancestor which can still be found as a woody shrub with a cluster of small red berries. The scarlet eggplant is a major vegetable in West Africa and especially so in the region between northwest Nigeria and Senegal. Here called the 'garden egg', belonging to the 'Gilo' group, which is well established in areas between savannahs and the more humid Guinean belt. The somewhat bitter types of garden eggs are mainly used in stews whereas the sweeter, flattened and lobed types (belonging to the 'Kumba' group, more often found in drier areas) are eaten fresh.

A totally different group called 'Shum' is used for its leaves and young shoots and is harvested ratoon-wise whereby new side shoots will develop and these can be harvested again after a few weeks. The leaves are smaller and lack the star-shaped hairs normally found on leaves of garden egg varieties used for their fruits. The Shum group of varieties is normally found in the more humid belt with a heavier rainfall such as east Nigeria and the Cameroons. These plants are much smaller than garden eggs and their fruits have a diameter of only 1 cm or less when compared with most garden eggs which reach 5 cm on average and sometimes even up to 8 cm.

Research on garden eggs has been carried out in Ivory Coast and Senegal, resulting in a few new higher yielding and stable varieties. Research is also carried out in France, together with the Netherlands and the U.K. through the so-called EGGNET project (eggplants network) which deals with the aubergine, garden egg (also called scarlet eggplant) and the gboma eggplant (*Solanum macrocarpon)* and their wild relatives. All these eggplants are autogamous and therefore very much inbred, making it comparatively easy to produce new hybrids which are uniform, combining various properties.

Cooperation between various countries in Africa is presently on a very low level. What is required is a network of African researchers similar to ESIN, the European Solanaceous Information Network, to share their knowledge and to be able to study and use the great diversity present in germplasm available through an exchange of materials. Major yield improvements could then be foreseen with further improvements in quality attributes whereby desirable characteristics could become more pronounced. Once botanical, molecular and germplasm information are combined, further uses could be envisaged through e.g. industrial use.

Solanum americanum (Solanaceae)
There is a lot of confusion about the correct names of the species complex, usually referred to as *Solanum nigrum*. The real *S. nigrum*, which is poisonous, is probably not found in Africa whereas the crops we are dealing with probably belong to either *S. scabrum* or *S. americanum*. The monograph on this group which is currently being prepared by Prof Chweya, may give some further insight in this taxonomic puzzle.

It is a leafy vegetable which is of local importance in a number of districts in high rainfall zones spread throughout tropical Africa. Its fruits are usually removed before cooking.

In Kenya's Kisii and South Nyanza districts, people collect from weedy, wild populations and also sow them in home gardens. Since the prices fetched on local markets and especially in cities, are lucrative due to high demand, there is now a tendency to commercialise this crop as pure stand plots. In southeast Nigeria the crop is commonly found on commercial plots where it is grown in mixed plots together with other leafy vegetables. Here it is commonly grown for use in the kitchen and less often for sale in the markets because of its perishability whereby it does not remain fresh for long enough to warrant transport over long distances.

Black nightshade requires large amounts of nitrogen and flourishes when adequate quantities of compost or manure have been incorporated into the soil. Germination is markedly lower

when the crop is sown on non-fertilised land. Generally, this crop is much affeced by aphids, especially during the dry season.

In Kenya yields of up to 30-50 tons per acre have been obtained on experimental plots whereby the 'eldoretti' type (probably *S. scabrum*) even yielded 80 tons per acre. In Kenya there are at least six distinctly different varieties or (sub)species as they are referred to by some authorities, with either dark blue to black or orange to red berries.

The *Solanum nigrum* complex has been subject to a number of studies in Kenya, including MSc and PhD thesis. Most of these studies emphasized nutritional issues and relatively limited work has been carried out on breeding, agronomic or post-harvest topics. Also in west Africa there is relatively little work carried out on this crop, which does not receive a high priority. Much work has been done in India and surrounding countries but it is not certain whether or not we are talking about the same species as the ones cultivated in Africa.

Solanum macrocarpon (Solanaceae)
The wild progenitor of this ancient species is *Solanum dasyphyllum* which has hairy leaves and spiny stems, contrary to the cultivated hairless varieties grown for their leaves. It is found in West, East and Southern Africa with a wide variety in forms. In East and Southern Africa it is predominantly used for its fruits whereas in West Africa there are groups of varieties which are mainly grown for their leaves and others mainly for their fruits, which could be in many different shapes, colours and sizes.

The gboma eggplant is found at lower altitudes and in more humid places than the scarlet eggplant mentioned above. It is generally less bitter and is often used as a snack which is eaten fresh. For Nigeria's igbos the fruits are used together with cola nuts at the beginning of ceremonies and other special occasions to ensure a successful conclusion. The price for such fruits can therefore be very high on certain days.

Leaves and shoots can be collected over a long period, making this a very high yielding crop. Its leaves are either cooked and served on their own, eaten together with yams or other starchy food or alternatively leaves can be added to soups and sauces.

When compared with the scarlet eggplant, relatively limited research has gone into this well established crop. The same remarks about its autogamy can be made, whereby breeding work could be fruitful within a relatively short time, once given access to a diversified genepool. Research has been more intensive outside Africa such as in southeast Asia and it may be worthwhile to establish links with researchers in that region.

Talinum triangulare (Portulacaceae)
Waterleaf is commonly found as a weed and harvested by workers in the field or by people who collect them from waste land near their homes throughout most of sub-Saharan Africa's more humid areas. There are only few places where they are cultivated on a large scale and even less so as pure stand. One of these areas is in Nigeria's Akwa Ibom State from where the produce is transported to markets in Calabar and Port Hartcourt. In Ibadan waterleaf can be seen in large quantities at Apata farmers market where produce is brought as early as 5 o'clock in the morning but after 8 in the morning the produce is usually no longer seen.

Once this crop is cooked, it releases a lot of water and only limited substance to be eaten is available. Therefore, people often dry it first before cooking. The vegetable is rather slimy and is therefore appreciated by many people in especially West Africa.
It is also eaten as a raw vegetable in salads.

Its high oxalate content, also found in the related *Portulaca oleracea*, is one of the drawbacks for this vegetable. Therefore, once germpasm has been collected from *T. triangulare* and the more drought tolerant *T. paniculatum* and other related species, selections could be made based on its oxalate content

Most research on waterleaf carried out, especially in Nigeria, deals with its nutritive value and to a limited extend with taxonomical issues. More work has been carried out in Thailand and the Philippines where larger varieties can be found. It does however originate from central Africa where there is a wide variety of wild material available for further screening.

Telfairia occidentalis (Cucurbitaceae)
The fluted gourd has never been known from the wild although it most likely originated in the area between Owerri and Enugu in southeast Nigeria. For Igbos it still is the most popular leafy vegetable. Its popularity has recently spread beyond Lagos in the west and also the Cameroons in the east. Outside Nigeria it is not so well known and if so, then mainly for its immature edible seeds rather than for its shoots and leaves. The crop can however be found all the way along the West African coast from Sierra Leone to Zaire. The oyster nut *Telfairia pedata*, which is occasionally found in Zanzibar and along the coast of Tanzania and Mozambique is closely related. Here only seeds are used either raw or toasted as a substitute for almonds. According to literature oyster nuts are also produced in India. There is also a third African *Telfairia*, *T. batesii*, which is rarely found in the Camerouns as a wild plant.

The immature, large, fleshy seeds of the fluted gourd are shelled and roasted and used as a snack. When they are used as mature seeds they have to be washed first to remove the dye found around the cotyledon. Such seeds when ground are less tasty. Mature seeds are also a good source of edible oil and ground seeds make cakes which are high in protein. Seed yields however, are low and seeds are very valuable as planting material.
Telfairia roots can be very poisonous and root extracts are used to kill rats and mice but could also be lethal when consumed by people.

When planting *Telfairia* for its leaves, by far the most common use, farmers space the seeds at 25 x 25 cm or occasionally even closer, and harvest for the first time after one month, followed by 2-4 weeks intervals when new shoots are formed. There is evidence that female plants have a considerable higher yield than male plants, partly because their leaves are larger. It is grown both in the dry and in the rainy season and is the main vegetable eaten together with pounded yams. In contrast, when planting for fruit or seed production the spacing has to be wide, given that the vines may grow into trees where the large fruits, weighing up to 20 kg can be found.

Seeds are recalcitrant and will die when dried. The best way to keep them for up to six months is inside the fruits where the moisture is about 65 %. This also means that seed transport is only possible inside the large (up to 50 x 20 cm) fruits. Farmers leave seeds in the open for a few hours to reduce their moisture percentage to about 40%, which appears to provide the best germination conditions.

There is a need for researchers to find varieties which produce more fruits to overcome the serious shortage of seeds for planting and for consumption purposes. Research is suggested to use the non-recalcitrant seed character of oyster nuts in breeding efforts to overcome seed storage problems for the fluted gourd.

Vatovaea pseudolablab (Leguminosae)
In semi-arid regions this leguminous crop can be found as a climber amongst local shrubs. It is a real multi-purpose crop of which virtually all parts can be eaten such as the roots, which in roasted form are a favourite snack. These roots differ in shape from long and slim, carrot-like

to round potato like. Also the leaves, the young pods and the seeds are eaten either raw or cooked. Hadza women in northern Tanzania supplement their diet with these tubers which can be dug out of the ground at any time of the year and are considered juicy and sweet. In Kajiado, Kenya, some people have planted seeds in a first effort to cultivate *Vatovaea pseudolablab* as a crop. It will be interesting to learn about their experience and to see whether these efforts represent the first phase of a domestication process. In the opinion of several people who know these plants, the potential available in this species is very much worth exploiting. To do so, a start needs to be made by collecting and evaluating germplasm. Preliminary selections could then be tested for their performance and promising material should be multiplied further which should not be too difficult, assuming that it is basically a self-pollinated crop. These selections could then be disseminated to interested people in various parts of East Africa to be tested for their adaptability to prevailing climatic conditions and for their acceptance as food. The species is found wild in the dry parts of Tanzania, Kenya, Uganda, Sudan, Ethiopia, Somalia, Yemen and Oman. It is commonly collected from the wild in all these countries but is not or hardly cultivated. In the Arabian peninsula it is now becoming rare and in East Africa becoming scarcer, being a favourite of people and livestock alike. If no action is taken soon, the genetic pool of this valuable species is likely to shrink fast. In southern Africa interest is developing for *Tylosema esculentum*, the marama bean, that has similar multi-purpose uses as a root and pulse crop.

Vernonia amagdalyna. (Compositae)
This shrub is often planted in Nigeria as a hedge and could be used as a live fence in home gardens. It is called bitter leaf since as its name implies, leaves of traditional varieties are usually very bitter. Recently, selections have been made which suffer less from this problem. Housewives know that when the foam disappears from the leaves whilst being washed, they have become less bitter. There are also a number of related species used as a vegetable, which are similarly bitter, including *Vernonia colorata*, a crop more frequently found in Ghana's savannah belt, *Vernonia hymenolepis* from mountainous areas in Cameroun, Uganda, Kenya, Tanzania and Ethiopia and *Vernonia cinerea*, which is semi-cultivated in Kenya and Tanzania. *Struchium sparganophorum*, also called the water bitterleaf is locally common in southwest Nigeria where it is especially consumed during the dry season.

Most people can collect what they need from their own garden. Many cuttings can be made from the same plant for most of the year as long as the crop receives some water e.g. waste water without detergents from households.

Vernonia bitterleaves, which are generally multiplied by sticking a shoot in the soil and not through seeds, are commonly found throughout Nigeria and also in neighbouring states even though not as frequent. Substantial research has been carried out on nutritional analyses etc but little on agronomic practices or genetic enhancement.
Further research is needed to find varieties that are not bitter at all, followed by dissimination of this material. It is understood that there is now also a demand for more bitter types to be used in the malting process for the production of beer.

It is interesting to note that *Vernonia amagdalyna* is used by Chimpansees as a medicine to treat intestinal nematodes and especially *Oesophagostomum stephanostomum* for which they swallow whole leaves and chew the bitter pith of the branches This happens especially during the rainy season and has been observed in Tanzania but also in West Africa for the related pygmy chimpanzee.

Vigna unguiculata (Leguminosae)
The cowpea which is indigenous in several countries in Africa has been in cultivation for a long time and numerous varieties are known which are used for the leaves or for the seeds. It is mentioned here because its leaves can be a major local vegetable. It is however considered

a crop which has been domesticated to a significant extend and extensive literature is readily available. Most of these domestication efforts are geared towards cowpea as a pulse cropwhereas there is less demand for special leafy varieties since these are already available in existing germplasm.

Several other species of *Vigna* are being used by people and some have a great potential such as *Vigna frutescens* from Kenya, the roots of which are described as carrots of the future. Yet, this potential crop is still waiting to be exploited. Also the bambara nut, *Vigna subterranea,* which originated from West Africa's savannah belt, has undergone domestication as a pulse crop. There is now renewed interest in this crop and especially so in Zimbabwe and other southern African countries due to their drought tolerance. Considerable work has already been carried out by IITA and others, whereas in the context of this paper it is not really considered to be a vegetable. In addition, a monograph on bambara nuts is currently being prepared by IPGRI.

APPENDIX 2: MARKET SURVEYS IN NIGERIA AND KENYA

2A: Survey on horticultural crops found in Enugu's urban and peri-urban markets.

Introduction

1. Many observers have stated that eastern Nigeria is the place where indigenous vegetables play a more important role than exotic vegetables like tomatoes or cabbages. To quantify those statements a market survey was needed for which Dr Okafor from FAME centre in Enugu was asked to conduct a one -week study on three markets, representing both markets for the more affluent people and markets for the less well off.

Methodology used

2. Discussions were held with market masters and leaders of commodity unions, where applicable. These discussions centered more on units of sale such as small heaps, bundles or bags of various sizes in order to be able to compare quantities put on offer. Units of sale were found not to be standardised and could be different for the various commodities. Besides, these units vary depending on season, quality and even time of the day. In total 43 stand holders were interviewed, using both inventory forms and structured questionaires.

3. It was decided to select three markets for the study: a) the main market where next to fruits and vegetables, a wide range of other commodities like textiles and hardware were on offer. This market is visited mainly by the urban well to do, b) the new market (Aria market) and c) the Orie Emene market. The last two markets are mainly frequented by people with little money to spend and located in an urban (=b) and a peri-urban setting (=c).

4. To place vegetables into the context of a more general food supply, observations were made simultaneously on root crops like yam, cassava etc, on various fruits, on cereals and pulses, on seeds and nuts and on miscellaneous spices. The total number of such products observed in the three markets mentioned was 79, out of which there were 18 traditional vegetables. No observations were made on livestock and derivative products, including bush meat, eggs, fish etc. since such a survey would be beyond the scope of the present studies. These studies focus on cash cropping opportunities for the urban and peri-urban underprivileged and on an offshoot study on the status of indigenous vegetables in Enugu.

Findings

5. Exotic vegetables like lettuce, cabbage, beans, onions, cucumber, tomatoes, green pepper and watermelon were only seen at the central market. These crops were brought in from northern Nigeria in small quantities but fetched a price which was sometimes up to ten times the price quoted for local vegetables. Even in the central market, the only place where they were seen, only 2 out of 14 stall holders interviewed offered these luxuries. Most other products and especially the indigenous vegetables could be seen in each market whereby most stall holders had a wide choice of local produce on offer.

6. It was noticed that the majority of produce offered, and especially the vegetables, originated from within Enugu State even though a lot was produced in outlying districts of Abokaliki and even more in Nsukka. Most of the perishable vegetables were found to have been produced within the city and in its peri-urban areas. One notable exception were garden eggs of which its leafy Shum types were produced locally but fruit types had to be brought in from Kano in the north.

Some of the heavier commodities such as pulses and root crops came from both local sources and from the northern parts of the country and less so from the middle belt. These commodities were handled by traders who have connections throughout the country, some of whom handle quite large volumes.

7. In addition to the main markets mentioned above, there is also a significant trade at community or at street corner markets. Here people sell their home garden produce, often for a low price and in small quantities only.

8. The survey was carried out during the second half of June which is the rainy season. A note was made that at this time vegetables are cheap since most people can collect them from the wild or from their own gardens. Both volumes offered at markets and prices are generally higher during the dry season when there is a general scarcity and demand cannot be met. At that time the urban poor may not be able to afford fresh vegetables in their daily diet.

Table 3. Ranking of traditional vegetables sold at three Enugu markets, based on turnover and number of traders involved. June 1996

Nr	Crop		Number of traders selling (N= 46)	Average Daily Turnover/trader
1	Fluted Gourd	*Telfairia occidentalis*	38	N 244
2	Amaranth	*Amaranthus spp.*	38	N 181
3	vegetable from trees	*Pterocarpus soyauxii*	34	N 161
4	Garden egg (leaves and fruits)	*Solanum aethiopicum/ Solanum macrocarpon*	40	N 91
5	Black nightshade	*Solanum americanum*	23	N 40
6	Bitterleaf	*Vernonia amygdalina*	17	N 38
7	Pumpkin	*Cucurbita moschata*	28	N 34
8	Guinean pepper	*Piper guineense*	30	N 33
9	vegetable from trees	*Gongronema latifolia*	34	N 28
10	waterleaf	*Talinum triangulare*	36	N 22
11	Basilicum	*Ocimum gratissimum*	21	N 16
12	Jute mallow	*Corchorus olitorius*	12	N 5

Table 4. Prices (in Naira) of selected commodities offered at 3 markets in Enugu

Crop	Unit of Sale (retail)	Central Market	New Market	Orie Emene Market
Rootcrops				
Yam	1 tuber	50	40	40
Cocoyam/ edo	5 tubers	5	5	5
Sweet Potato	7 tubers	50	25	20
Cassava-sliced	cup	6	4	5
Cereals/Pulses				
Rice	cup	12	12	10
Maize	cup	5	5	5
Sorghum	cup	7	5	5
Egusi melon	cup of seeds	16	16	15
Cowpea	cup	12	12	10
Soybean	cup	7	8	8
Pigeon Pea	cup	6	7	8
Bambara nuts	cup	10	10	10
Groundnuts	cup	12	12	12
Traditional Vegetables				
Fluted Gourd	small bundle	5-10	5	5
Amaranth	" "	5	5	5
Pterocarpus	" "	15	10	10
Garden egg	" "	5	5	5
Black n-shade	" "	5	2-5	2-5
Bitterleaf	" "	5	5	2
Pumpkin	" "	5-10	5	5
Guinea pepper	" "	5	5	3
Gongronema	" "	5	5	5
waterleaf	" "	5	2-5	5
Basilicum	" "	1	1½	1
Jute mallow	" "	5	5	5
Okra	7 fruits	5	5	5
Exotic Vegetables				
cabbage	kg	50		
green beans	kg	80		
sw. capsicum	each	10		
carrot	4 carrots	10		
tomato	5 fruits	50	20	20
Fruits				
mango	5 fruits	20		
orange	5 fruits	20		20
plantain	5 fruits	40	40	30
banana	5 fruits	10	10	10
pawpaw	1 fruit	20	15	10
pineapple	1 fruit	10-30	10-30	10-30
avocado	1 fruit	5-10	5	5

2B: Market survey carried out in Kakamega, and nearby rural markets

Introduction

Under the guidance of Silvanos Otukho from the Kenya Agricultural Research Institute, a one-week market survey was conducted to assess the supply of vegetables as part of the total availability of food crops on Kakamega's municipal market and to compare this with supplies of vegetables on nearby small-scale rural markets. Kakamega is a regional capital of Western province and the area is humid by Kenyan standards. Most people in Kakamega town depend on their staple food purchased from markets whereas many families grow at least some crops in their gardens, especially local vegetables.

Methodology

Traders were interviewed at random when many arrived at the same time, otherwise, all traders were asked about the produce they brought, its origin, quantity and wholesale as well as retail price. For those traders who could not be interviewed in detail, records were made on the type and quantity of produce. The survey was conducted for 7 consecutive days from 1 to 7 June between 6 A.M. and 6.P.M., using two shifts of staff. Enumerators were selected from KARI's Regional Research Centre staff, extension staff from the department of agriculture and personnel from Kakamega's municipal council. A total of 315 traders were interviewed in Kakamega plus 20 traders in Kiboswa and 10 traders in Chavakali rural markets.

Results

Most produce offered at the municipal market originates from production areas in other provinces, including imports from Uganda, whereas local produce mainly concerns fruits, indigenous vegetables and minor cereals, root, pulse and oil crops.

The survey involved fifty different types of crops. Many indigenous vegetables and minor crops do not reach the market since they are either eaten at home or at the community level rather than being offered to local traders. At the time of the survey most people had indigenous vegetables at home so that demand and prices were low and only small quantities were offered for sale. During the dry season the opposite is usually the case with limited home production, hence a high demand and high prices with some farmers concentrating on such crops so that larger quantities can be found at the market when compared with the wet season.

Marketing

Itinerant traders and wholesalers operating country-wide, have local buyers in the main production areas of the country from where they despatch their lorries to regional markets such as Kakamega, for the produce to be available on the main market days, Saturday and Wednesday. The most common operators however are relatively small businessmen who buy directly from a farmer or from a collection centre and transport the produce directly to Kakamega. They receive most of their information on supplies and prices from other traders and not from the radio, which they consider as unreliable. These traders can operate from long distances. Most of the local traders buy small quantities of produce from community members and sell these at a profit. Small farmers often feel that they are being taken advantage of because they do not know the actual prices at a given time.

Small-scale producers of indigenous vegetables and minor commodities bring their crops to the market directly. This is done daily or even twice daily and is not influenced by whether or not it is a main market day. In case of indigenous vegetables, such farmers may either sell the produce directly or through traders at the market. The latter have a gross margin of approximately 50-125 %, depending on the time of the day and on the freshness of the produce.

Table 5: Local Indigenous Leafy Vegetables found in Kakamega Market. Jume 1996

Crop	*Latin name*	Abaluya name	Weight in kg	Whole -sale price Ksh	Retail price Ksh
Cowpea leaves	*Vigna unguiculata*		1816	6	10
African Spinach	*Amaranthus lividus*	Dodo	1018	2.5	5
Jute Mallow	*Corchorus olitorius* *	Mrenda	973	5	10
Ethiopian Kale	*Brassica carinata*	Kanjira	630	4	10
Sunhemp	*Crotalaria brevidens* *	Mito	608	5	10
Spider Flower	*Gynandropsis gynandra*	Saga	585	6	8
Black Night Shade	*Solanum nigrum*	Sutsa	335	6	10
Pumpkin leaves	*Cucurbita moschata*		90	**	12

* Next to *C. olitorius*, there may also be some *C. trilocularis*. Amongst the sunhemp there is a large volume of *C. ochroleuca*, which is often more preferred because it is less bitter.
** All pumpkin leaves came from small or home gardens and was sold directly by the producer.

Table 6: Exotic Vegetables found in Kakamega market. June 1996

Crop	Origin	Weight in kg	Wholesale Price in Ksh	Retail Price in Ksh
Cabbage	Nakuru	48025	9	12
Tomatoes	Kitale	5105	9	15
Onions	Uganda	5007	15	20
Kale	Kapsabet	4285	10	14
Shallot	Local Farmers	2862	10	30
Carrot	Kapsabet	925	4	10
Peas	Aberdares	521	6	10
Cucumber	Kisumu	25	17	25
Egg Plant	Kisumu	25	17	25

Out of the sales people interviewed, 10% were farmers selling their own produce on a retail level, 42% bought consignments from a farmer and 48% bought their produce from a wholesaler who in term purchased commodies from other traders or markets.
In Kakamega's Municipal Market 79 % of traders interviewed were women, 20 % were men and about 1 % were a husband and wife team, working together.

Retail traders handled small volumes, which they carried as headloads or on shoulder slings. They sold from market stalls but more often from a small open space on the floor, along roadsides or just outside the market to avoid paying market fees.

Handling of produce
The local vegetables are brought to the market in bags, very early in the morning, having been picked during the previous afternoon. Indigenous vegetables are often brought late in the afternoon as well when they are still very fresh and can command a good price. A bag may contain several types of vegetables, which are subsequently sorted out and re-bundled and offered for sale in small heaps or as a tied bundle. It is not sold on a weight basis but apparently always in a small heap of varying size with in most cases a constant price. The amount of produce in a heap depends on the time of the day and freshness of the produce. Traders can either sprinkle some water on the produce at night or leave it as it is and do this

early in the morning. Water makes green vegetables to appear fresh but many traders have noticed that it also induces fungi and could cause a rapid deterioration.

Most indigenous greens are offered as a total plant with their roots attached. Later in the season when this thinning on the farm has been finished, green vegetables are offered as shoots or tops, especially for those crops which can be ratooned. This is often not the case for *Corchorus*, which is virtually always offered as a whole plant since new side shoots are not easily formed.

Agricultural Crops

During the first week of June 1996 traders brought a total of 8870 kgs of cereals, mainly maize from Kitale, with small quantities of finger millet, sorghum and rice from neighbouring areas. Next to this dry maize, there was a further 16.5 tons of green maize. Irish potatoes from Mt Elgon region and from Timboroa dominated with 24060 kg in the root crop sector, followed by just over 2.5 tons of sweet potatoes and some 285 kg of cassava and cocoyam from local farmers. Grain legumes were important with over 24 tons of beans from Kitale, in addition to some local green grams, bambara nuts, soybean and cowpeas. Also the oil crops groundnuts and sesame, both from Busia, were represented with 2610 and 3060 kgs respectively.

Fruits

Most fruits came from within the province with pineapples from Malava being most important with 2685 kgs, followed by 10 other species, each with relatively small quantities. All fruits belong to the so-called exotic types and no wild or indigenous fruits were found on the market.

The Rural Markets of Kiboswa and Chavakali

On these small rural markets there were virtually no exotic crops present. Interestingly though, Kiboswa was found to serve as a collection or assemblage centre for indigenous vegetables, destined for Nairobi and Kisumu. Due to the high demand from long-distance markets, local retail prices were on average Ksh 20 per kg, which is about twice the price demanded in Kakamega. It was also noted that in Kiboswa, a small village, the quantity found on a one day visit virtually equals the amount brought to the Kakamega Municipal Market in a full week. These vegetables were produced by small-scale growers, some of which turned into businessmen who discovered that there is a good demand for their produce from amongst the Abaluyas living in the big cities.