Development of Mechanisms for Sustainable Production and Utilisation of Indigenous Vegetables and Management of their Genetic Diversity in Uganda

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EXECUTIVE SUMMARY

Farmers and consumers currently make use of over forty plant species, or different parts of species that they identify as indigenous vegetables. Indigenous vegetables form a significant part of the local vegetable diet and are deeply interwoven with local customs and beliefs. While the precise origin of most indigenous vegetables is unknown, many of the indigenous vegetables can be found in other parts of Africa suggesting that such vegetables may be of African origin. The rural population particularly the women have a lot of indigenous knowledge on the production and utilization of indigenous vegetables yet this knowledge and its value is not fully recognised by the researchers. The main objective of this phase was, therefore, to collect indigenous knowledge from farmers regarding agronomy, water use, integrated pest and disease management, farming systems, seed technology, crop diversity, *in-situ* conservation practices, processing, preservation and utilisation practices of indigenous vegetables and determine how much of it is applied in the farmers' daily activities.

The selection criteria for the collection of the indigenous knowledge were that the selected parishes must be those with the highest levels of indigenous vegetable cultivation for household and commercial purposes. The main criteria were extent of the existence and abundance of the different species and varieties of indigenous vegetables available and the significance of indigenous vegetables in the different localities. The research team, made up of nine researchers from various backgrounds, were selected based on knowledge, experience and relevance to the multidisciplinary team approach of collecting the indigenous knowledge.

Initially it was proposed that a Participatory Rural Appraisal (PRA) be carried out as part of the process to collect indigenous knowledge relevant to the use and production of indigenous vegetables. This, however, was not possible due to shortage of time so a more rapid approach was used. Relevant PRA tools, however, were used to collect contextual information relating to the district and parish and the indigenous knowledge concerning the local cultivation and utilisation of the indigenous vegetables. Individual and focus group interviews were held with district agricultural officials, parish chairpersons and local farmers. As is appropriate with collecting indigenous knowledge a number of specific questions were developed before hand to ensure that information relevant to future indigenous vegetable research was generated and recorded. The fieldwork process of collecting and analysing the indigenous knowledge was as follows: the Extension Officer facilitated the introduction of the research teams to the farmers and local residents. Background information relating to the parishes was collected from individual interviews with farmers visited during the transect walk and large group discussions held with local residents and farmers. Information relating to local circumstances and indigenous knowledge on the cultivation and use of indigenous vegetables was also collected in this manner.

The research teams noted the upward trends in indigenous and exotic vegetable production and the allocation of land and labour to commercial indigenous vegetables were indicators of this. Both men and women were involved in planting indigenous vegetables and carrying out pest and disease control activities. Besides listing indigenous vegetables, farmers listed exotic vegetables, traditional food and cash crops and livestock as important local agricultural produce. According to the farmers, indigenous vegetables have always been eaten and the consumption trend is increasing. It is important to note that some indigenous vegetable plant types provide a number of different foodstuffs that

the farmers and consumers identified. An example of this is the indigenous vegetable known as bikeke. The leaves of the pumpkin plant are eaten and given the name ebisunsa while originally the plant was produced for its fruit (young pumpkins which are eaten and known as ebikeke, while older pumpkins are also eaten but are known as enywongo). The time line and other information suggest that indigenous vegetables have been produced in the country for many years. However, the local production of indigenous vegetables has been overtaken by the increase in the production of exotic vegetables for commercial purposes. Farmers and consumers believe that preserving the use of indigenous vegetables is important because of their apparent nutrient content and the fact that they are more resilient to the local environmental constraints when compared to exotic vegetables. They suggested a number of ways to do this including preserving seeds for future generations and generating information on optimising the cultivation and use of indigenous vegetables.

Farmers and other residents identified a number of indigenous vegetables that they believe are now extinct or are very scarce. Some are still used while others are not. In light of disappearing indigenous vegetables, it is necessary to carry out in-situ conservation in conjunction with the farmers

The farmers complained of several production constraints including the diseases and pests which are considered to be a threat to the production of indigenous vegetables. Farmers did not, however, differentiate between the different indigenous vegetable plant species and the different diseases and pests that afflict them. Observations by the research teams during the transect walks supported the farmers' statements that most indigenous vegetables seemed to be less susceptible to disease and pests than the exotic vegetables. Scattered intercropping was also observed and farmers said this practice repels pests from the indigenous vegetable crops. The research findings indicated clearly that farmers had very limited or no solutions to the many constraints they were facing in indigenous vegetable growing.

Farmers use their own seeds for all types of indigenous vegetables that they cultivate. They collect the seeds from the vegetable crops, and occasionally from wild or volunteer plants, such as *Solanum nigrum* and *Amaranthus dubius*. Occasionally farmers obtain seeds from other farmers but these occasions are rare. Farmers prefer their own seeds to those of other farmers, as they are not sure of the quality of other farmers' seed. Farmers also do not purchase seeds since there is no apparent market for seeds of indigenous vegetables in many areas. They observed that local indigenous vegetables seeds are easy to process. Seed drying is considered to be an important process as experience has shown the farmers that dried seeds tend to germinate better. Men have a dominant role in raising seeds for commercial vegetables such as *Solanum aethiopicum*, while women have this role for indigenous vegetables predominantly grown for household consumption, such as *Amaranthus dubius* and *Lycopersicon esculantum*. Before sowing, farmers do not follow any special seed preparation practices such as scarifying or, chemical seed treatment to promote seed germination. For all cultivated vegetables, seeds are sown by the broadcasting method. Unlike commercial farmers, smallholder farmers do not grow a crop for seed. They allow a few plants from the vegetable garden to flower and provide the seed for the next crop. The farmers clearly demonstrated their knowledge that poor quality seed was a result of inadequate drying and storage facilities. To this extent only pest and disease free plants are harvested for seeds.

The harvesting method of leafy vegetable depends on whether it is harvested for household consumption or for commercial purposes. Generally preference is for fresh

cooked indigenous vegetables with only a few consumed in their raw or dried state. The preparation process for dried indigenous vegetables is the same for both leafy and fruit. The indigenous vegetables are processed by either steaming and drying or drying without steaming. Indigenous vegetables are not only utilised as “food” and for sale but some also have medicinal and cultural values.

Farmers believed that they were unable to produce enough indigenous vegetables to meet their household needs throughout the year although they sold some of their excess indigenous vegetables during times of plenty to generate extra income.

Farmers rely mainly on rainfall to irrigate their crops. According to farmers, the supply of water from other sources does not remain constant during the dry season. Farmers complained that sometimes this resulted in crops withering and dying. A few farmers draw water from wells, boreholes and springs to irrigate crops, including the indigenous vegetables, during the dry season. Some farmers observed that when such water was used to irrigate crops during the dry season, it did not help the situation. The farmers’ perception was that rain-fed indigenous vegetables grow better and faster in comparison to irrigated ones. The daily activities for the household, however, did not indicate fetching irrigation water but only fetching water for household consumption indicating that very little water was spared for irrigation of the vegetables. Most farmers rely predominantly on dryland cultivation practices.

Farmers indicated that indigenous vegetables do not deplete the soils but instead help in maintaining the nutrients in the land. Indigenous vegetables are rotated with other crops including exotic vegetable crops. The farmers generally have significant knowledge on many aspects of indigenous vegetable cultivation. However, there are many issues for which they are unable to generate solutions. Consequently there is scope for cooperation between formal scientific research and farmers’ own knowledge and innovations. These can complement each other to bring about improved cultivation of indigenous vegetables in line with farmers’ and local residents’ needs.

It was noted that indigenous vegetable farmers do not have any formalised marketing strategy and rely heavily on the terms dictated by the market and the consumer demand for their vegetables and other factors such as seasonality. If there is abundance of indigenous vegetables at the market, the farmers end up throwing away their unsold quantities. Farmers suggested that their indigenous vegetables could be processed to increase shelf life so that vegetables could be stored for longer periods until the market demand was available.

1.0 INTRODUCTION

Whenever inadequate amounts of essential nutrients are provided, nutritional deficiency or inadequacy results and affects all developmental growth, efficiency of labour and the span of working life, which eventually influences the economic potential of a country. Nutritional studies have shown that nutritional deficiency may also lead to very low haemoglobin levels in infants and pregnant women, the elderly and sick people in addition to increasing the prevalence of night blindness. The diet of average rural dwellers in Uganda is known to be deficient in proteins, iron, calcium, vitamins B and C, riboflavin and often iodine. All these nutrients can be obtained largely from locally available indigenous vegetables. Table 1 indicates the nutritional value of some of the vegetables utilized in Africa.

Table 1: Nutritional composition of some vegetables grown in Sub-Saharan Africa

Vegetable	Part	Protein (g)	Fat (g)	Sugar (g)	Fibre (g)	Vitamins (mg)		
						A	B	C
Lagos spinach	Leaf	4.7	0.7	8.0	1.8	-	-	-
Fluted pumpkin	Seed	20.5	45.0	23.0	2.2	-	-	-
Livingstone Potato	Tuber	4.7-5.2	0.8	23.4	3.5	3.4	-	-
Crotalaria brevidens	Shoots	4.2-4.9	-	-	-	1.7-5.2	-	115-129
Okra	Fruit	1.8	-	31.0	-	0.06	-	18
Okra	Leaves	2.0	-	33.0	-	0.59	-	25
False Rosselle	Leaves	3.3	0.3	9.0	1.6	2.4	0.17-0.45	54
Black nightshade	Shoots	2.8 – 5.8	0.8	3.3-5.0	0.6-1.4	1.0-6.6	-	-
Jute marrow	Leaves	5.6	0.3	7.6	1.7	-	-	-

Source: Schippers (2000).

Farmers and consumers currently make use of over forty species, or different parts of plants that they identify as indigenous vegetables. The most popular plant species are Doodo (*Amaranthus* spp), Nakati (*Solanum aethiopicum*), Entula (*Solanum gilo*), Enyanya entono (*Lycopersicon esculantum*), Malakwang (*Hibiscus sabdariffa*), Jjobyo (*Cleome gynandra*), Gobe (*Vigna unguiculata*) and the fruity solanum spp (Ntula, Katunkuma etc).

Indigenous vegetables form a significant part of the local vegetable diet and are deeply interwoven with local customs and beliefs. They are also used for medicinal purposes and have an important role in local ethno-medicine. Despite the introduction of commercial exotic crops in recent years, indigenous vegetables have retained their presence and have actually increased in terms of the quantities cultivated for commercial purposes. However, these are lower than the quantities of exotic crops produced for commercial purposes. The land allocated for indigenous vegetables is less than that made available for exotic vegetables because the commercial demand for exotic vegetables is still higher. Based on the information obtained from farmers and consumers it is believed that the indigenous vegetables will continue to enjoy significance, although some might disappear and be replaced by others over time as has happened in the past.

While the precise origin of most Uganda indigenous vegetables is unknown, some of the indigenous vegetables can be found in other parts of Africa suggesting that such vegetables may be of African origin. The rural population particularly the women have a lot

of indigenous knowledge on the production and utilization of indigenous vegetables but can not fully explain the medicinal and nutritional value of the indigenous vegetables which are usually considered poor man's food. Indigenous knowledge (IK) here refers to the knowledge, which people in the farming community in Uganda have developed over time and which they continue to develop (IIRR, 1996; Langill, 1999). It is based on:

- Experience that clearly include external influences;
- Tried and tested over generations of use;
- Local environmental conditions and culture;
- It is dynamic and changes continuously

Particular groups possess particular indigenous knowledge (especially the elderly) with limited spread to and adoption by the majority. There is, therefore, need to collect, document, package and disseminate the indigenous knowledge. Building on the indigenous knowledge, there is need to analyse and quantify medicinal and nutritional values and develop appropriate preservation and processing methods which minimise loss of these values.

Conventional approaches to development and agricultural development in particular have failed to realise the desired results in the developing world largely due to their inappropriateness and failure to recognise the knowledge possessed by local people. To overcome this, it is increasingly evident that developers have to build on "what the people know and researchers of all disciplines need to "start with what the people have". This practice allows for the development of appropriate assistance and technology in collaboration with rural and urban users, which they can sustain. Ugandan researchers were aware that the bulk of existing knowledge relating to the cultivation and utilisation of indigenous vegetables was in the hands of the rural growers and users. The researchers were also aware that for any future research to have optimal significance to the rural producers and Ugandan consumers, it would have to be based on their knowledge, experience and requirements. This knowledge, therefore, was recognised as a vital resource for indigenous vegetables development initiatives to complement scientific knowledge. An increasing number of development professionals have also come to realise the importance of this resource. As a result of the recognition of the benefit of IK, it was decided that IK on the cultivation practices and the use of Ugandan indigenous vegetables needed to be collected as a first step to defining the appropriate areas of research in a larger research project.

This phase, carried out by Ugandan researchers and a South African partner, was to determine how the future identified project phases would be implemented. The main objective of this phase was, therefore, to collect indigenous knowledge from farmers and end users regarding agronomy, water use, integrated pest and disease management, farming systems, seed technology, crop diversity, *in-situ* conservation practices, processing, preservation and utilisation practices of indigenous vegetables. This information was to be analysed and used to identify the important areas for future research.

The role of the Ugandan partners was to:

- Identify the areas that were to be used to collect indigenous knowledge
- Develop a checklist of desirable information;
- Analyse results and compile the report.

The role of the South African partner in this phase was to:

- Join the Uganda partners in using the PRA tools and in the process of collecting the indigenous knowledge in a test district as well as two other districts;
- Assist with analysing the indigenous knowledge recorded.

Knowledge was sought from local smallholder farmers, many of whom grow indigenous vegetable crops and have done so for generations, making them good sources of knowledge. It was further envisaged that the collection of this knowledge would locate the cultivation and utilisation of indigenous vegetables within the livelihood practices of the Ugandan smallholder farmers, both the commercial and mainly subsistence farmers, thereby indicating its significance and the relevance for further research. Given time and other resource constraints for collecting the desired information, the primary purposes of the research presented in this report was to collect the following data:

- **Baseline data**
  Baseline data is necessary for the proposed research project in order to evaluate it and determine the impact it achieves on end users, the Ugandan smallholder farmers. By involving the farmers in the process at this early stage they are in the position to indicate what is important to them and to identify the criteria for the evaluation of impact, i.e. criteria relevant to them.

- **Indigenous Knowledge relating to the cultivation of indigenous vegetables**
  To prevent unnecessary costs relating to duplication of knowledge and to ensure that future assistance is based on what people have and know, the importance of collecting and analysing indigenous knowledge relating to the indigenous vegetables was acknowledged.

2.0 RESEARCH METHODOLOGY

2.1 Areas selected for the collection of indigenous knowledge

For the purposes of this phase eight districts were selected in accordance with the locally practised farming system (Table 2), representing Eastern (Tororo Mbale and Soroti), Central (Mpigi and Rakai), Western (Hoima) South western (Mbarara) and Northern (Lira).

Table 2: Parishes selected in the study districts

Farming system	District	Sub-county	Parish
Intensive banana-coffee lakeshore	Mpigi	Muduma	Mutubagumu - Tiribogo
Pastoral and some annual cropping	Rakai	Nabigasha	Bethelehem
Medium altitude intensive banana-coffee	Mbale	Nambale	Tsabanyanya
Annual cropping and cattle-Teso	Soroti	Kamuda	Amint
Banana-millet-cotton	Tororo	Busaba	Busaba
Annual cropping and cattle-northern	Lira	Adekokwok	Ongica
Western banana-coffee	Mbarara	Bugamba	Kamomo
Western banana-coffee	Hoima	Mparo	Butabere

One parish was selected in each of these districts as the sites for IK collection The Ugandan members of the research team identified the selected districts based on their knowledge of the main farming system utilised in each district. Each parish was selected by the extension staff in the district and sub-county in consultation with the elders in the community and district officials. The selection criteria were that the selected parishes must be those with the highest levels of indigenous vegetable cultivation for household and commercial purposes. This was to obtain a focus group type setting for the research team.

It was important to collect information from different districts and parishes around Uganda to determine:

a) The extent of the existence and abundance of the different types and varieties of indigenous vegetables available;
b) The extent and variations in terms of the scarcity of indigenous vegetables in different areas and reasons for this;
c) The significance of indigenous vegetables in the different localities;
d) The differences in knowledge relating to the cultivation and utilisation of indigenous vegetables.

2.2 Research team

The research team was made up of the following persons who were selected based on knowledge, experience and relevance to the multidisciplinary team approach of collecting indigenous knowledge on indigenous vegetables:
Dr. Elizabeth Rubaihayo – Plant Breeder and Agronomist - Kawanda Agricultural Research Institute
Professor Patrick Rubaihayo – Biotechnologist and Plant breeder - Makerere University -
Professor Edward Kakonge – Nutritional Biochemist - Makerere University
Dr. Flavia Kabeere – Seed Technologist - Kawanda Agricultural Research Institute
Dr. Johnny Mugisha – Agricultural Economist, Lecturer - Makerere University
Dr. James Tumwine – Plant Pathologist - Kawanda Agricultural Research Institute
Mr. John Kawongolo – Agricultural Engineering Lecturer - Makerere University
Mr Achileo Kaaya – Food Technologist, Lecturer - Makerere University
Mr. Tim Hart – Agricultural Sociologist - Agricultural Research Council Infruitec-Nietvoorbij - South Africa (Only present during the research in Mpigi and Hoima.

This group of researchers was split into two teams. Team one which collected indigenous knowledge on indigenous vegetables in the Hoima, Mpigi, Rakai and Mbarara districts was made up of Dr. Elizabeth Rubaihayo, Professor Edward Kakonge, Mr. John Kawongolo, Mr. Tim Hart and Dr. Johnny Mugisha. Team two which collected information from the districts of Tororo, Mbale, Soroti and Lira was composed of Prof. Patrick Rubaihayo, Mr. Acheleo Kaaya, Dr. James Tumwine and Dr. Flavia Kabeere.

2.3 Tools and process used to collect Indigenous Knowledge

Initially it was proposed that a Participatory Rural Appraisal (PRA) be carried out as part of the process to collect indigenous knowledge relevant to the use and production of indigenous vegetables. Due to the following reasons the proposed format was changed:

- The amount of work that had to be done in the time allocated was insufficient for a PRA to be practically carried out to its conclusion. Only five days were budgeted and

allocated to data collection in each of the parishes. The short period of time could not be used to achieve significant participation, of stakeholders, gather in-depth indigenous knowledge, and present a summary analysis to the stakeholders and farmers. The farmers themselves were not able to sacrifice five consecutive days to participate in the knowledge generating activities;
- The limited budgets of the Ugandan and South African partner organisations;
- The need for the South African partner to stay for a short period of three weeks of which one week was allocated for the analysis of the collected data;
- The fact that the main purpose was to collect indigenous knowledge relating to a specific crop as opposed to doing a full PRA that would lead to a community development action plan;

The process and tools, therefore, were adapted to fit in with the above constraints without reducing the validity, reliability and value of the generated indigenous knowledge. Unfortunately the quantity and depth of the data was reduced because people often spoke in general terms about their activities and did not always identify specific practices for each indigenous vegetable. In some cases where some conflicting statements were made it was not possible to confirm all of these as detailed analysis of the data only occurred after the field visits had been concluded. These issues can be verified in the main project where it is hoped resources will be adequate.

While many of the PRA tools were used, a more rapid, as opposed to participatory approach was adopted in light of the mentioned constraints. To this end the following adaptations were made:

a) The members of the research team recorded most of the information after explaining the purpose of the PRA tools; and
b) Some of the PRA tools were exchanged for group discussions with the participants and the research teams making notes on the information generated from these discussions. Notes were not always displayed to the participants for final verification.

These adaptations allowed the indigenous knowledge recording process to be completed within the allocated time frame. The following PRA tools were used to collect contextual information relating to the district and parish and the indigenous knowledge concerning the local cultivation and utilisation of indigenous vegetables:

- Transect walk
- Social and natural resource mapping
- Livelihood mapping
- Time lines
- Pair-wise ranking
- Trend charts
- Seasonal calendars
- Group interviews

Individual and focus group interviews were held with district agricultural officials, parish chairpersons and local farmers. As is appropriate with collecting indigenous knowledge a number of specific questions were developed before hand to ensure that information relevant to future indigenous vegetable research was generated and recorded. In order to validate data presented to the research team the following activities were carried out:

- The PRA tools were used in a fashion that allowed for the triangulation of the data collected ensuring that all data was verified and crosschecked. One example of this

was the use of the transect walk to observe the practices carried out and to have discussions with some of the farmers who were not present at the meetings;
- Involving large numbers of local people and allowing them to freely agree or disagree on the information they presented and verify the data generated.

On the last day of fieldwork, unless otherwise stated, all the information was presented to the farmers and local officials for the verification of the data collected by the research teams. The fieldwork process of collecting and analysing the indigenous knowledge was as follows:

- Day one
  Interview with District Officials and with the Parish Crop Extension Officers. The Extension Officer facilitated the introduction of the research teams to the farmers and local residents. Background information relating to the parishes was collected from one farmer.

- Day two
  Transect walk of selected areas in parishes that were identified by the farmers and the Extension Officer. Individual interviews with farmers visited during the transect walk.

- Day three
  Large group discussions held with local residents and farmers relating to local circumstances and indigenous knowledge on the cultivation and use of indigenous vegetables.

- Day four
  Meeting with District Officials, some farmers and working on the data analysis and development of the report of the District.

- Day five
  Feedback to some officials and farmers. Travelling from the District

3.0 RESULTS OF THE STUDY

3.1 Income and expenditure – main sources and areas of expenditure

The main source of income and most important livelihood resource comes from local agricultural activities. The household consumes a large proportion of agricultural produce but there seems to be an increasing trend towards producing a surplus and selling this. Income generated in this way is used to pay for essential goods and services. There is also an increasing trend towards concentrating on crops that have a known commercial value once the household food supply is taken care of or in conjunction with this. The upward trends in indigenous and exotic vegetable production and the allocation of land and labour to commercial indigenous vegetables are indicators of this. Where the parishes bordered on the urban areas, some income was also derived from public and private sector employment. Income was spent on some externally produced commodities such as essential goods such as soap, sugar, salt and clothing. The farmers reported that a significant portion of income was spent on education and health services. Very little money is spent on external agricultural inputs, as farmers generally do not have the money to purchase these and apply them as required.

3.2 Women's issues – projects and role in agriculture

Some women's groups exist in the districts. There are a number of local projects specifically for women that receive government, non-government or foreign aid. Women have a vital role to play in agriculture and in the maintenance of the household. Within the household they are responsible for preparing meals for the household (including fetching water and firewood), looking after and supervising the children, cleaning the house, washing household items and clothing and repairing clothing. The time clock for gender activities indicated that women are responsible for a number of key agricultural activities. They are engaged in manual labour throughout the day in the fields, with the nature of the activity changing with the seasonal requirements. Men tend to do most of the preparation of fallow land; especially chopping trees. Women hoe the land and clean previously cultivated fields between the various planting times. Both men and women plant crops and carry out pest and disease control activities. Men and women are jointly involved in harvesting of crops.

3.3 Indigenous vegetables found in the districts

Besides listing locally utilised indigenous vegetables in Uganda (Table 3), farmers listed exotic vegetables, traditional food and cash crops and livestock.

Table 3: A list of the indigenous vegetables found or produced in the districts

Scientific name	Indigenous names in the Survey Districts							
	Hoima	**Mbale**	**Mbarara**	**Mpigi**	**Lira**	**Rakai**	**Soroti**	**Tororo**
Amaranthus dubius	Doodo	Doodo	Doodo	Doodo	Aboga/obuga	Doodo	Eboga	Doodo
Amaranthus graecizans			Enyabutongo	Embooge		Emboge		
Amaranthus cruentus	Omujuiga		Omuriri					
Amaranthus blitum		Buga	Emboga	Buga		Ebugga		
Solanum nigrum	Enswiga	Siga	Eswiga	Ensuga	Ocuga	Eswiga		Siga
Phasiolus vulgalis (Bean leaves)	Ebisoboza		Ebijamba	Ebisoboza		Ebijanjalo		
Vigna unguiculata (Cowpeas leaves)	Omugobe/ Enkoole	Gobe	Omugobe	Egobe	Boyo	Egobe	Boyo	Gobe
Cucubita maxima (Pumpkin leaves)	Ebisunsa	Sisa/ssunsa	Ekisusha	Esunsa	Acwica	Esusa		Sisa/ssunsa
Lycopersicon esculantum (Small tomatoes)	Enyanya enyoro/ enke	Obunyanya	Obunyanya obukye	Obunyanya obutono		Obunyanya obuganda	Enyanya atino	Obunyanya
Solanum anguivi	Obutura	Katunkuma	Obutura	Katunkuma		Katunkuma		Katunkuma
Cleome gynandra	Eyobyo	Jobyo	Eshogye	Jobyo	Akeo	Ejobyo	Akeo	Jobyo
Cajanus cajan	Enkuuku		Enkuuku	Enkolimbo				
Phasiolus lunatus			Ebigaaga			Ebigaga		
Erucastrum arabica	Oburo bwenaku		Empande	Empande		Empade		
Allium spp (Small onion)			Obutunguru (obukye)	Obutungulu obuganda		Obutungulu obutono		
Cororus sp. (Yam)	Eteke		Ebitekyere					
Capsicum spp. (Hot pepper)	Ekamurali		Eshenda	Kamurali		Kamulali		
Manhot escullant (Cassava leaves)	Ebikora bya muhogo		Amababi gamuhogo			Sobe		
Malra verticilata			Mirankwongyere					
Crotalaria spp								Aleyo
Rottboella					Wowo			

cochinchinensis								
Basella alba	Nderema	Nderema	Enderema	Enderema				Nderema
Erucastum arabicum			Empubika					
Solanum aethiopicum	Obugorra	Nakati	Nakati	Nakati		Nakati		Nakati
Solanum gilo	Enjagi	Ntula	Entonga	Entula	Tula	Entula		Ntula
Phaseolus lunatus				Obuyindiyindi/ Ebigaaga		Ebiyindiyindi		
Hibiscus sabdariffa	Bamya	Malakwanga			Amalakwang		Amalakwang	Malakwanga
Corchoris trilocularis/ C. olitoris					Otigo		Otigo	
Asystasia gangetica					Alaju			
Crassocephalum rubens					Apulukur			
Hibiscus cannabinus					Gwanyir			
Oxygonum sinuatum					Esugugur			
Cyphostemma adenocaule					Moros		Moros	
Colocasia esculanta	Ebihuna	Timpa		Timpa		Etimpa		Timpa
Asystasia schimperi					Acwe wanggweno			
Euphorbia heterophylla								Nabusondo
Asystasia schimperi								Nandera
Corchorus olitorius/ Corchorus trilocularis		Mutere						Mutere
Celosia trigyna								Namudagada
Boerhavia diffusa								Halojo
Cleome monophylla								Hasaga Mubindu
Cucurbita maxima (fruit)	Ebikeke/ Ebitontozi		Ebyozi/emyongo			Ensuju		
Crotalaria Spp					Rwotopwo			
Cassia obtusifolia					Oyado			

Farmers were asked to rank these production categories and the consensus was that production for household consumption is of primary importance after which any available surplus is sold. Despite the emphasis on household consumption, all households need income to pay for essential goods and services. The implication is that all households probably attempt to sell some of their produce to generate an income. Table 3 indicates that most of the cultivated indigenous vegetables were common in all the districts visited – only differing, in some cases, by local names.

The research team, however, noted that some indigenous vegetables are no longer popular and are therefore no longer consumed or only in very small amounts. Nonetheless, the increase in the popularity of other indigenous vegetables coupled with their commercial significance has resulted in the increase in their cultivation and availability (for sale and for own consumption). According to the local residents, indigenous vegetables have always been eaten and the consumption trend is increasing.

It is important to note that some indigenous vegetable plant types provide a number of different foodstuffs that the farmers and consumers identified. The leaves of a particular indigenous vegetable at a certain stage of its lifecycle might be identified as a particular foodstuff and given a particular name. Later in the lifecycle of the same plant the older

leaves might be eaten or the developed fruit might be eaten. These are given different names. Other indigenous vegetables might only provide one type of foodstuff only once during the lifecycle or during the entire lifecycle resulting in it being locally identified in terms of this particular foodstuff. An example of this is the indigenous vegetable known as *bikeke*. The young sliced and dried pumpkins are eaten as source and given the name *bikeke*, while originally the plant was produced for its fruit (old pumpkins known as *emyongo/Ensuju/ebyozi*) and the young leaves known as *ebisunsa* are also eaten. The pods of the cowpea plant are eaten when green separately or with the young leaves and the dish then is known as *Gobe*. But the green or dry seed when eaten is called *enkole*. The people based the ranking of indigenous vegetables on how widely they were available in the parishes and not on economic preference. However, the latter can influence availability for in some areas people tend to cultivate what they can sell. Hence, the most important indigenous vegetables are those, which are the most widely available. Discussions with farmers suggest that availability is based on economic value and on popularity. However, some exotic plants that have been grown in Uganda for generations were among the very popular vegetables for example cabbage, tomatoes, onions and *sukumawiki*. Table 4 shows the highly popular indigenous vegetables. The farmers' criteria are considered to be more important for food than commercial value/demand. Where the commercial demand was more significant than the household food, it was used as a determinant for ranking.

Table 4: Most important indigenous vegetables in the districts

Scientific name	Common local name
Amaranthus dubius	Doodo
Amaranthus blitum	Buga
A. cruentus	Omuriri
Vigna unguiculata	Gobe
Solanum indicum	Katunkuma
Cloeme gynandra	Jjobyo
Solanum aethiopixcum	Nakati
Solanum gilo	Entula
Hibiscus sabdariffa	Malakwang
Solanum nigrum	Nsugga

The time line and other information suggest that indigenous vegetables have been produced in the country for many years. However, the local production of indigenous vegetables has been overtaken by the increase in the production of exotic vegetables for commercial purposes. This poses a threat to most of the indigenous vegetables, which may disappear since they are competing for the same resources and markets. Farmers reported that they still continue to cultivate indigenous vegetables because they are hardier, more resilient to pests and diseases and most importantly are an important means of sustenance for the household. Only eight indigenous vegetables seem to be sold on a wide scale in most urban centre markets: *Solanum aethiopicum*, *Vigna unguiculata*, *Hibiscus sabdariffa*, *Solanum gilo*, *Amaranthus lividus, A. blitum, S. anguivi* and *Cloeme gynandra* (Plate 1). The elderly and the women are credited with playing an important role in preserving the use of indigenous vegetables and continue to do so as it is said they are aware of the nutritional value of these crops. Farmers and consumers believe that preserving the use of indigenous vegetables is important and suggested a number of ways to do this:

- Educating people about the nutritional value of these crops;
- Preserving seeds for future generations;

Plate 1: Indigenous vegetables as found in urban center marketplaces

Solanum aethiopicum **- Nakati**

Vigna unguiculata**- cowpea**

Hibiscus sabdariffa **- Malakwang**

Solanum anguivi **- Katunkuma**

Solanum gilo **- striped Ntula**

Abelmoschus esculentus **- Okra**

Amaranthus blitum **- Bugga**

Amaranthus dubius **- doodo**

Brassica oleracea **- Sukumawiki**

Giving them information on optimising the production and use of indigenous vegetables.

3.4 The extinction, scarcity and conservation of local indigenous vegetables

The farmers in the Northern and Eastern regions did not indicate any disappearing vegetables. They still collect a lot of the vegetables particularly in the Northern region from the wild. The farmers in Central and Western regions of the country and other residents identified a number of indigenous vegetables that they believe are now extinct or are very scarce. They also identified vegetables that are available but no longer used. Some of these vegetables and the reasons for their extinction, scarcity or disuse are listed in Table 5.

Table 5: Indigenous vegetables that used to grow

Indigenous vegetable	Districts (Type of growing)	Reasons for disappearing
Amaranthus spp (Ebuga enganda)	Mpigi, (W)	Lack of seed, No market, Pests and diseases
Solanum spp (Nakati enganda)	Mpigi (G)	Lack of seed, No market, Pests and diseases
Amaranthus spp (Ebuga enganda)	Rakai (G)	It was overtaken by exotic cabbage People do not have access to seeds
Entungo (Sim sim)	Rakai (G)	It was associated with rigid rituals to be performed before eaten. For example, the first harvest had to be eaten by the husband in order not to die in case others ate it before he eats the dish.
Dangu	Rakai (G)	Current generation does not eat it. It was eaten by Indians who no longer reside in Bethelehem.
Ekicuragyenyi (Urtica massaica)	Mbarara (W)	Ignorance of the current generation about it's preparation. This vegetable is found in forests and swamp edges. More work should be done, it is drought food; very good for children.

Legend: W = Wild; G = Grown

The discussion with the farmers and consumers suggested a trend towards producing and using indigenous vegetables, which are of commercial value, usually easy to prepare, and considered to be both nutritious and tasty. Those that are not considered as such tend to be replaced. Taste preferences will probably continue to change implying that the popularity of different types of indigenous vegetables will continue to change. The market demand seems to suggest a preference for certain tastes, as most of those that are sold are those, which are considered tasty, nutritious and have medicinal properties rather than those that are used for rituals. The replacement of Omujwiga by Doodo in Hoima is an indicator of this. It is evident from Table 5 that very little active conservation is being carried out on the part of farmers. This is largely a result of the lack of current interest in the unpopular plants, resulting in their scarcity. Current existence is because they are volunteer crops and if the existing ecological niches were destroyed these indigenous vegetables would also be destroyed.

3.5 Agronomy

3.5.1 Annual production trends and land required

Non-commercial farmers were unable to give monthly or annual proportions of the amount of land that they use for producing indigenous vegetables because of their common practice of intercropping as opposed to mono-cropping specific areas and the fact that they use different areas including the backyard during the year. The size of the area allocated to a particular crop is dependent on the land currently available. Farmers often use areas of land that were not previously used or that they consider to be under-utilised. This has allowed them to increase their production of both indigenous and exotic vegetables. The farmers, however, complained of several production constraints, which included diseases and pests that are considered to be a threat to the production of indigenous vegetables. Farmers did not differentiate among the different indigenous vegetable plant types and the different diseases and pests that afflict them. Crops are sprayed as soon as diseases and pests are observed or believed to be present. Farmers stressed the high price of chemical pesticides and herbicides and, therefore, preferred homemade concoctions. These homemade concoctions could involve animal urine combined with ash and various other plants, either individually or together, such as chilli pepper, marijuana, or other plants to make a solution. Solutions are allowed to stand for a number of days (in some cases up to fourteen days) in order to draw and ferment. This mixture is then mixed with water in some ratios and sprayed on the crops.

The spraying process involves sprinkling droplets of the solutions on the plants or around the stems using a grass/thatch brush. They do not seem to be aware of the hazardous effect of chemical pesticides, which do not breakdown before the vegetables are ready for harvesting.

Individual farmers preferred local solutions but at group meetings most people seemed to want to buy pesticides and other inputs but claimed that they were very expensive. The reason for this difference seems to come from those engaged in more commercial focused activities. These farmers are finding it increasingly difficult to spray using traditional methods due to the increasing size of their land and the trend towards cultivating exotic vegetables, which seem to be less hardy. Such farmers are purchasing some pesticides and are using them predominantly on exotic vegetables. Manual control was only mentioned in the case of particular beetles and given the size of some farms it would be impossible to do this in any effective manner for all possible pests.

Observations by the research teams during the transect walks supported the farmers' statements that the indigenous vegetables seemed to be less susceptible to disease and pests than the exotic vegetables except in some cases like *Hibiscus sabdariffa* (Plate 2) where leaf beetles (*Ootheca* sp) do a lot of damage.

Plate 2: Leaves of Malakwang damaged by Ootheca mutablis

Scattered intercropping was also observed and farmers said this practice repels pests from the indigenous vegetable crops. However, it is not clear how effective intercropping and the locally brewed solutions are in controlling pests compared to purchased pesticides, an area that requires research. Besides, most farmers neither applied the solutions nor practiced intercropping resulting into serious pest and disease damage. The findings in Table 5 indicate clearly that farmers had very limited or no solutions to the many constraints they were facing in indigenous vegetable growing. This necessitates research efforts to improve the existing solutions and develop new ones.

Table 6: Indigenous vegetable production constraints

Indeginous vegetables	Constraints and solution to constraints			
	Pests	**Disease**	**Post harvest handling**	**Marketing**
Amaranthus sp	C	C, R	PR, PS, MC,	HB, GP, F
Solanum nigram	CL	R	PR, PS	
Phasiolus vulgaris (Bean leaves)	CL	R	PR, PS	HB, GP, F
Vigna unguiculata (Cowpeas leaves)	C	C, R	PR, PS	HB, GP, F, D
Pumpkin leaves		R	PR, PS	F
Lycopersicon esculantum (Small tomatoes)	C	C, CL,	PR, MC	HB, GP, F
Malakwang		R	PR, PS	HB, GP, F, D
Cleome gynandra	CL	R	PR, PS	HB, GP, F, D
Small onion		C	PS	
Yam leaves			PR, PS	
Hot pepper	C		PR, PS	
Cassava leaves			PS, PR	D
Entula	C	R	PR, PS	
Nakati	C, CL		PR, PS	HB, GP
Katunkuma	C	R	PR, PS	HB, F
Aduru		R	PR, PS	
Mirankwogyere			PR, PS	
Enkunku (Lablab purpureus)			PR, PS	
Obuyindiyindi (Phaseolus lunatus)			PR, PS	
Okwe (Cucunus figarei)			PR, PS	
Moros (C. Adenocaule)			PR, PS	
Esugugur (O. sinuatum)			PR, PS	
Otigo (C. olitoris)			PR, PS	
Alaju (Crotolaria ochroleuca)			PR, PS	
Bojo (Amaranthus graecizans)			PR, PS	
Amola (Hyptis spicigera)			PR, PS	
Basella alba			PR, PS	
Euphorbia heterophylla			PR, PS	
Asystasia schimperi			PR, PS	
Corchorus olitorius			PR, PS	
Celosia trigyna			PR, PS	
Boerhavia diffusa			PR, PS	
Cleome monophylla			PR, PS	

Possible solutions: C-Chemical, R-Resistance, CL-Cultural, M-manurering, PR-Preservation, PS-Processing, HB-Hire bicycles/Tracks, GP form and sell as a group, F-Give excess to friends, D-Dry the excess

It is important to note that about half the list of vegetables in Table 6 is collected from the wild.

3.5.2 The local process of indigenous vegetable production

Farmers do not distinguish between the activities that they undertake to cultivate the different types of indigenous vegetables. They explained that the process of cultivation is very general with only a few variations among the different vegetables. Smallholder farmers follow approximately six steps in cultivating indigenous vegetable crops. Differentiation of labour can occur at different times during the different steps (Table 7).

Table 7: Steps undertaken to cultivate indigenous vegetables and the inputs used

Steps	Description of process	Gender Roles	Inputs used
Step One	Clearing bush from fallow land and burning of dried plant matter	M/F	Labour Machete/panga Hand Hoe
Step Two	First digging: turn over the soil and organic matter using the hoe	F/m	Labour Hand Hoe
Step Three	Second digging: turn over soil and organic matter again using a hoe to make a fine seed bed. This is done 2 weeks after the first digging	F/m	Labour Hand Hoe
Step Four	Planting: seeds are sown by broadcasting or seedlings that have been raised in seed beds or collected from the wild are transplanted in the prepared garden. Seedlings are usually not transplanted in rows.	F/m	Labour Hand Hoe Own seeds and seedlings, or Wild seedlings
Step Five	Weeding and pest control: crops are weeded by hand Some farmers spray with ash/hot pepper/urine/water mixtures for pest control	F/m	Labour Hand Hoe Homemade mixtures Grass brushes
Step Six	Harvesting: this depends on the type of vegetable and the season	F/m	Labour Knives Baskets or containers

F, M=females and male more active, respectively; f, m=females and males less active

The cleared shrub and bush is burnt. This ash is worked into the soil using hand-held hoes. A few weeks are allowed to pass and then the field is again worked using the hand-held hoes followed by planting. The commercial farmers may apply animal manure (chicken manure being preferred since it does not carry weed seeds as in the case of cattle manure) or fertilizers before planting. Seeds, usually made by the household, are sown or seedlings are transplanted. Weed, pest and disease control is done manually throughout the rest of the growing period. The farmers whose main purpose is to produce for home consumption do not use inputs such as insecticides, herbicides, fungicides or fertilisers. As vegetables mature, the whole plants or leaves are harvested and are either mainly consumed at home or sold, depending on the type and variety of vegetables. When the fruits are used as vegetables, they are picked before ripening. The picking may take several months depending on the species.

3.5.3 Seed source preferences

Farmers use their own seeds for all types of indigenous vegetables that they cultivate. They collect the seeds from the vegetable crops, and occasionally from wild or volunteer plants, such as *Solanum nigrum* and *Amaranthus dubius*. Occasionally farmers obtain seeds from other farmers but these occasions are rare. Money is seldom exchanged for seeds. A system of exchange or reciprocity exists between some farming households. Farmers prefer their own seeds to those of other farmers, as they are not sure of the quality of other farmers' seed. Farmers also do not purchase seeds because there is no market for seeds of indigenous vegetables in many markets. They observed that local indigenous vegetables seeds are easy to process. The exotic vegetables seeds are normally imported and stocked by stockists who in most case are in towns far away from the farmers' rural settings.

3.5.4 The process of raising of seeds

The process of raising seeds for the major indigenous vegetables is described in Table 8.

Table 8: Preparation of indigenous vegetable seeds

Indigenous vegetable	Description of process	Reason for the process	Time required for the process
Amaranthus dubius	• Uprooting or cutting of old plants with seeds (inflorescence) • Drying of seeds • Threshing, cleaning of seeds • Storing seeds in banana fibres, calabashes, tins, polythene bags or simply by hanging plants over the fire place in the kitchen	• Traditional practice to uproot or cut old plants with seeds • Seeds are stored over the fire place to prevent them from absorbing moisture and being damaged by storage insect pests	• Very short. No specific length of time was given • Depends on weather conditions
Amaranthus blitum	• Uprooting or cutting of old plants with seeds • Drying of seeds • Threshing, cleaning and storing dried seeds • Storing of seeds in banana fibres, tins, calabashes, polythene bags or simply hanging plants over the fire place in the kitchen	• Traditional practice to uproot or cut old plants with seeds	• Very short. No specific length of time was given • Depends on weather conditions
Vigna unguiculata	• Picking of mature pods or partially dry from the garden • Threshing of pods • Cleaning and sorting of seeds • Mixing seeds with ash and occasionally pepper or tobacco leaves • Storing seeds in polythene bags, tins or in granaries (for pods) until next planting season	• Traditional practice. Farmers have always done it this way	• Very short- No specific time given as it varied from farmer to farmer and size of plantings and seeds required
Solanum indicum	• Picking of fruits that are very ripe • Piecing fruits with a small stick on which they are then dried over the fire place in the kitchen, or simply sun drying • Crushing of fruits to extract seeds from them • Sowing of seeds by (broadcasting) in a seed bed or simply broadcasting them in a banana plantation	• It is a tradition. Farmers have always done it this way	• Very short • No specific time given • It varies from farmer to farmer and depends on weather conditions
Cloeme gynandra	• Uprooting or cutting of old plants with mature fruits • Drying of fruits • Crushing of fruit to extract seeds • Cleaning of seeds • Storage of seed in, tins or calabashes	• Traditional practice. Farmers have always done it this way	• Length varies from time to time. • It depends on the weather conditions
Solanum aethiopicum	• Picking old and very ripe fruits • Squeezing seeds out of fruits or piecing fruits with a stick on which they are then dried over the fire place in the kitchen, or simply sun- drying the fruits • Crushing dry fruits to extract seeds from them	• Traditional practice. Farmers have always done it this way.	• Very short • No specific time given • It varies from farmer to farmer and size of plantings

	• Cleaning of seeds • Storing seeds in bottles, calabashes, and tins over the fire place. Dry fruits in are tied in banana fibres and hanged over the fire place • Sowing of seeds directly in the seeds bed		and seeds required. It also depends on weather of the day
Solanum gilo	• Picking dry fruits or very ripe ones • Halving and piercing the cut fruits with small sticks on which they are then dried over the fire place in the kitchen, or simply sun-drying intact or pieces of fruit • Crushing fruits to extract seeds from them • Storing the seeds or dry fruits in a dry place (the kitchen) • Sowing seeds (by broadcasting) in a seed bed or simply broadcasting them in a banana plantation	• It is a tradition. Seeds from fruits that are half way ripe/raw have germination problems	• Very short • No specific time given • It varies from farmer to farmer and depends on weather conditions
Hibiscus sabdariffa	• Picking of the ripe fruits • Crushing of fruits to extract seeds • Drying of seed and storing them in a dry place (kitchen)	Dry seed germinate better	Very short

Seeds are harvested and they are dried, processed, cleaned and sorted to improve their quality. Seed drying is considered to be an important process as experience has shown the farmers that dried seeds tend to germinate better. Male and female adults usually share the seed making process more or less equally. Men have a dominant role in raising seeds for commercial vegetables such as *Solanum aethiopicum*, while women have this role for indigenous vegetables predominantly grown for household consumption, such as *Amaranthus dubius* and *Lycopersicon esculantum*. When the seeds have been properly dried, they are stored until the next planting season. Before sowing, farmers do not follow any special seed preparation practices such as scarifying or chemical seed treatment to promote seed germination. Farmers follow different practices depending on the type of indigenous vegetable. For all cultivated vegetables, seeds are sown by the broadcasting method. Some are sown in nurseries e.g. *Solanum gilo.* Unlike commercial farmers, smallholder farmers do not grow a crop for seed. They allow a few plants from the vegetable garden to flower and provide the seed for the next crop.

Farmers indicated that seeds are stored in calabashes, tins, bottles and bags, which they hung in a dry place (the kitchen). This practice is said to reduce the incidences of insect pests attack and kept the seeds dry. Banana fibres are also used for storage and hanging the seeds in the kitchen.

3.5.5 Problems of raising seeds and solutions

Although some farmers processed and preserved seed for future planting seasons as well as future generations, seed unavailability remains one of the key constraints in indigenous vegetable production. Many farmers preserve little and mainly for personal use. The study identified a number of problems in the process of raising seeds that explain why seed availability was a constraint. These include:
A number of problems were identified in the process of raising seeds:

1. During periods when there are high incidences of pests and diseases, it is difficult to get enough suitable seeds for planting.

2. Seeds are often blown away and lost as a result of strong winds during the drying and processing activities.

3. The farmers clearly showed that poor quality seed was a result of inadequate drying and storage facilities. During the rainy season, seed drying is delayed and seeds stored in leaking houses/kitchens and granaries get damp. Under these conditions seed viability deteriorates; they may germinate or rot, thus making them useless.

4. Farmers have poor storage facilities and this seems to cause a major part of the problems encountered in raising viable seeds.

5. Storage pests usually destroy seeds with the main ones being rats and cockroaches.

6. In the case of vegetables that are scarce or seldom used, it is very difficult to obtain the seeds.

7. Problems associated with the germination of seeds were particularly encountered during dry season sowing and this was attributed to lack of sufficient soil moisture required for germination.

8. The young generation is not well informed of the process of seed preservation and the remedies to the above-stated problems.

The farmers listed the following coping mechanisms currently in use:
- Only pest and disease free plants are harvested for seeds;
- Seeds are usually dried under sheds to prevent the seeds from being blown away by the strong winds;
- Dried seeds are tightly tied in banana fibres and hung above the fire in the kitchen. The smoke from the fire permeates through the fibres. This practice seems to keep them dry and protected from the storage insect pests.
- If they are being stored elsewhere away from the fire, they are occasionally taken outside to re-dry

3.6 Harvesting and utilisation

3.6.1 Harvesting practices

The harvesting method of leafy vegetable depends on whether it is harvested for household consumption or for commercial purposes. Harvesting for household consumption is done by plucking off the tender leaves from the crop and with this method of harvesting, the harvesting period for one crop ranges from three to twelve months depending on the type of vegetable. In the case of harvesting for commercial purposes, the leafy vegetables are uprooted, washed and tied in bundles.

The fruit vegetable harvesting is done by picking the fruits from the crop irrespective of the end use. The harvesting period ranges between six months to two years depending on the type of crop, irrespective of whether it is done for household or commercial consumption. The maturity of indigenous vegetables is generally based on the following criteria:
- The length of the period since planting;
- The height of the plant;

- The size of the leaves or the fruit, as is applicable;
- The colour of the fruit;
- Leafy vegetables should be harvested before they start to flower otherwise quality is reduced.

The maturity indicators and harvesting practices for some of the indigenous vegetables are presented in Table 9.

Table 9: Maturity indicators and harvesting practices

Indigenous vegetable	Maturity Indicator	How long do you harvest it	Describe method of harvesting	Gender role
Solanum aethiopixcum	• Length of period after planting • When the plant starts flowering it is old	1 month after planting when plants are uprooted 6-12 months if the leaves are plucked from the stems	• Uprooting the whole plant • Plucking the leaves from the stem	M/F
Solanum gilo	• Length of period after planting • Size of the fruit • Colour of the fruit	6-12 months depending on the care and attention paid to the plants	• The picking of fruits that are not ripe???	F/M/c
Cloeme gynandra	• Height of plant is usually one foot (30cm)	3-4 weeks depending on the soil	• Uprooting the whole plant • Plucking the leaves from the stem	F/M/c
Amaranthus blitum	• Size • Height of plant is usually one foot (30cm)	1 month	• Uprooting the whole plant • Plucking the leaves from the stem	F/M
Amaranthus dubius	Height of plant (1foot or 30cm) and size of leaves	1 month	• Plucking leaves	F
Vigna unguiculata	Size of the leaf	3 months	• Plucking leaves	F
Solanum indicum	Size and colour of the fruit	12 months	• Plucking of fruits from branches	F/C
Hibiscus sabdariffa	Size of the leaf		• Plucking the leaves from the stem • Uprooting whole plant	F/M
Solanum nigrum	Size of the leaf	1 – 3 months	• Plucking leaves	F

F, M, C=females, males and children more active, respectively; f, m, c =females, males and children less active

3.6.2 Postharvest problems

Farmers felt that they did not have any real problems during the actual harvesting activities. The problems seemed to occur after harvesting and these include:

- Lack of storage facilities for fresh produce,
- Lack of packaging facilities,
- Lack of processing facilities,
- Transportation of produce from the field and to markets is a problem,
- Marketing is a major problem especially during the peak season,
- Wastage of produce in case there is no one to buy the produce, the farmers throw the produce due to lack of storage and processing facilities.

The possible interventions should address the above constrains and these include:

- Design of storage facilities for storage of fresh produce for both farmers and traders at the market places.
- Design processing facilities for small and large scale processing of indigenous vegetables in order to increase shelf life. The processing facilities to include:
    - Drying either solar dryers or biomass heated dryers.
    - Steaming where applicable.
    - Milling to floor.
    - Blending or mixing of different types of indigenous vegetables.
    - Design of packaging facilities.

3.6.3 Preparation and cooking methods

Generally preference is for fresh cooked indigenous vegetables with only few consumed in their raw or dried state. Table 10 shows the preferred forms of eating the vegetables, reasons and gender preferences.

Table 10: Preferred forms of eating indigenous vegetables

Indigenous vegetables	Form of preference	Reasons	Gender or age preference	Preference by gender
Solanum aethiopixcum	Freshly harvested and steamed/boiled	• Considered to be more nutritious and tasty	All	M/F
Amaranthus lividus	Freshly harvested and steamed/boiled	• Considered to be more nutritious and tasty	All	M/F
Solanum gilo	Freshly harvested and steamed or raw	• Considered to be more tasty	All	M/F
Cloeme gynandra	Freshly harvested and steamed/boiled	• Considered to be more tasty	The elderly	M/F
Vigna unguiculata	Dried Freshly harvested and steamed/boiled	• Used mainly during times of vegetable shortage. • Considered to be more tasty	Mainly old people of both sexes seem to have supplies of dried product	M/F
Amaranthus dubius	Freshly harvested and steamed/boiled	• Considered to be more nutritious	Adults of both sexes	M/F
Solanum indicum	Freshly harvested and steamed/boiled	• Medicinal and tasty to elderly • Used during shortage of other vegetables	The elderly	M/F
Hibiscus sabdariffa	Freshly harvested and steamed/boiled	• Nutritious, tasty; bitterness can be reduced during preparation	Every member of the household	F/M

N.B. *Solanum indicum* is collected mainly from the wild

For leafy indigenous vegetables, the leaves are cooked and then eaten. The preparation process is as follows:

- Pluck the leaves from the entire stem/stalk,
- Sort the leaves and wash / rinse in water to remove soil or any contaminants,
- Chop the leaves,

- Steamed / boiled / fried or mixed with other stew depending on someone's preference.

The fruit of the indigenous vegetables are cooked and then eaten. The preparation process is as follows:

- Pick fruits from plant,
- Pluck off the stalks,
- Sort the fruits and rinse in water to remove soil and any contaminants,
- Chop the fruits to small pieces or leave them whole, and mash them after cooking.
- Steamed / boiled / fried or mixed into a stew with other ingredients depending on personal preference.

The preparation process for dried indigenous vegetables is the same for both leafy and fruit indigenous vegetables and includes the following steps:

- Pick fruits and pluck off the stalks or pick leaves from plant,
- Sort the fruits or leaves and rinse in water to remove soil and any contaminants,
- Steamed and dry or dry without steaming,
- Mill / pound / grind the dried fruits or leaves to floor,
- Package the flour in bottles or any sealed container or tied in banana fibres and hung above the fireplace.

It was noted that farmers were not sure of the status of the nutritional qualities of their vegetables after the different preparation and processing methods. Some of the freshly harvested leafy vegetables were analysed for their food value in this study before and after steaming and the results are presented in Table 11.

Table 11: Results of food value analysis of various indigenous vegetables expressed out of 100g sample on fresh weight basis

Area	Sample		Moisture (g)	Dry matter (g)	Protein (g)	Sugars (g)	Fibre (g)	Vit C (mg)	β Carotine (mg)	Vit A (mg)
Tororo town	*Cloeme gynandra* (Jobyo)	Fresh	90.16	9.84	2.47	0.76	2.44	9.17	7.39	4.43
		Steamed	93.30	6.70	1.80	0.64	2.40	3.50	4.71	2.83
Tororo upcountry	*Hibiscus sabdarifta* (Malakwang)	Fresh	82.91	17.09	6.37	2.36	2.88	12.64	3.88	2.33
		Steamed	90.13	9.87	2.99	1.08	2.81	4.02	2.40	1.44
	Brassica oleracea (Sukumawiki)	Fresh	84.66	15.34	6.24	3.08	3.88	19.11	4.27	2.56
		Steamed	88.90	11.10	3.49	2.39	2.09	10.04	15.15	9.09
	Solanuum nigrum (Nsugga)	Fresh	92.12	7.85	3.32	0.94	1.47	7.10	10.71	6.43
		Steamed	91.32	8.68	3.68	1.53	1.65	6.57	13.09	7.85
Impigi	*Amaranthus hybridus* (Doodo)	Fresh	88.12	11.88	6.84	2.02	1.95	14.49	18.11	10.87
		Steamed	87.81	12.19	5.55	2.36	1.72	11.41	12.95	7.77
Rakai	*Amaranthus blitum* (Bugga)	Fresh	87.98	12.02	11.77	1.25	2.60	8.09	13.34	8.00
		Steamed	93.38	16.62	6.43	2.1	2.49	8.66	19.88	11,83
Mpigi	*Solanum aethiopicum* (Nakati)	Fresh	83.28	16.72	6.06	1.47	3.62	12.22	21.53	12.92
		Steamed	89.31	10.69	3.32	1.33	2.14	6.2	12.70	7.62
Rakai	*S. aethiopicum* (Nakati)	Fresh	91.02	8.98	3.63	0.84	1.69	7.68	8.45	5.07
		Steamed	91.03	8.97	3.49	1.04	1.84	5.41	10.45	6.27
Mpigi	*Amaranthus dubius* Green (Doodo)	Fresh	85.82	14.18	5.40	1.11	2.25	12.72	10.08	6.05
		Steamed	85.62	14.38	2.57	0.63	2.58	9.70	19.17	11.50
Mpigi	*Amaranthus cruentus* (Omuriri)	Fresh	87.67	12.33	2.96	1.05	2.10	14.19	11.00	6.60
		Steamed	87.16	12.84	2.32	1.27	1.87	8.55	12.37	7.42

Nutritional tests of the processed products need to be carried out and recommendations for proper preparation methods for which nutritional qualities are maintained need to be given. It is clear from the results of the analysis that steaming reduces the nutritional value of the vegetables and yet different households also practice some more destructive preparation methods. These vegetables were found to contain sizeable amount of vitamin A, B and C, which are main ingredients in diet and their protein content was good compared to most staple foods in the area. Results similar to these were reported by Schippers (2000) as presented in Table 1 for other African indigenous vegetables.

3.6.4 Other uses of indigenous vegetables

Indigenous vegetables are not only utilised as household and commercial foodstuffs for sale but also have medicinal values and cultural uses (Table 12).

Table 12: Uses of indigenous vegetables

Indigenous vegetables	Home consumption	Sell	Medicinal and other uses
Nakati	1%	99%	• Medicine for skin diseases such as eczema and external ulcers • Reduces high blood pressure
Entula (S.gilo)	10%	90%	• Reduces high blood pressure • Cures worms in young children • Clears hangovers
Ejobyo	10%	90%	• Reduces high blood pressure • Cures worms in young children • Treats malaria and convulsions • Roots when chewed induce delivery
Enyanya Enganda	100%	-	• Leaves are used to soothe sore or inflamed eyes • Mixed with paraffin and poured over sore muscles to soothe pulled muscles and reduce inflammation
Enkolimbo	100%	-	• Cures worms in young children • Helps with labour/ childbirth
Ekigaaga/ Obiyindiyindi	100%	-	• It treats trachoma
Egobe	80%	20%	• Ceremonial in that it is cooked for in-laws • Pounded seed cures swollen parts of human body • Ceremonial dish for delivery of twins
Esunsa	100%	-	• Medicine for headache • Pregnant women use it as purgative during labour
Nsugga	100%	-	• Treats blood pressure • Cures malaria
Enderema	100%	-	• Helps with labour/childbirth • Assists with milk production for breast feeding • Treats measles
Emboge	100%	-	• Kills or chases snakes from houses (ground and mixed with water and sprinkled in house)
Amalakwanga	30%	70%	• Increases milk secretion by mothers during pregnancy • Taken during pregnancy for easy delivery • Sap of tender leaves cures affected eyes
Alayo	100%	-	• In boiled form, cures measles
Katunkuma	50%	50%	• Controls blood pressure • Cures jaundice

Indigenous vegetables are associated with a number of cultural rituals in some societies for example in Bunyoro, *enkolimbo* is associated with bad luck, especially for people who get too close to it while on their way to collect money from debtors. It is believed that in such instances of close contact the chances of recovering the debts are slim. For this reason it is grown as a border crop around other crops. *Emboga* is not supposed to be brought into the house in case it brings bad luck. Consequently it is prepared and eaten outside the house and all that is cooked must be consumed in one sitting, as leftovers may not be kept for later consumption. As a result of the associated taboos it has been almost completely replaced with *emboge*, which does not have these associated taboos. It is also believed that *Enderema* weakens the sexual strength of men. Similarly, the stems of *Entula* are supposed to be carefully disposed of after harvesting because it is believed that

if a man steps on them, his sexual organs and in particular his testes will be negatively affected.

3.6.5 Availability of indigenous vegetables to meet household food requirements

Farmers near urban centres believed that they were unable to produce enough indigenous vegetables to meet their household needs throughout the year. They sell a large proportion of their indigenous vegetables to generate income. Consequently very little remains for household consumption. They would prefer to have more indigenous vegetables of the popular varieties as the market considers them to be tasty and nutritious. The farmers that produced for household consumption purposes believe that they have enough for their requirements during the rainy seasons. The general feeling amongst residents of the areas visited was that given the current production level of the primary commercial indigenous vegetable crops even adding value to the present quantities would not solve their problems and satisfy their needs through the year. The household food requirements seems to be the issue here rather than meeting market demand, which seem to happen at the cost of household food requirements. The bottom line is that farmers would like to have enough for their own needs as well as to be able to produce enough for the market to ensure a steady income from sales.

A seasonal calendar showing the times of high and low availability of the various indigenous vegetables is given in Table 13. The Table indicates when households consider indigenous vegetables to be in plentiful or short supply.

Table 13: Seasonal calendar of availability of indigenous vegetables

Indigenous vegetables	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Nakati	X	X		X	XXX	XX	X			X	XX	XXX
Entula	X		X	XX	XX	X		X	XX	XX	XX	XXX
Bugga			X	X	X	X		X	X	X	X	X
Jobyo			X	X	X	X			X	X	X	X
Enyanya Enganda	X	X				X	X	X				X
Doodo			X	X	X	X		X	X	X	X	X
Egobe				X	X					X	X	
Enkolimbo									X	X	X	X
Timpa	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X	X X
Ssunsa			X	X X	X				X	X X	X X	X
Malakwang			X	X	X					X	X	X
Otigo	X	X	X	X	X	X	X	X	X	X	X X	X

XXX = this particular indigenous vegetable is in abundance
XX = this particular indigenous vegetable is available in reasonable amounts
X = this particular indigenous vegetable is available in very small amounts
A blank space indicates that the vegetable is not available for consumption at all.

Currently, exotic vegetables enjoy more market attention than the indigenous vegetables but the prices fluctuate enormously, as does the demand for them at different times of the year, especially before and after the main growing seasons. The discussions with the farmers showed that the farmers were willing to take a sacrifice on any one of the main commercially oriented crops if they could get a good price for their indigenous vegetables so that some could be saved for household use. When indigenous vegetables are scarce

or seasonally unavailable, consumers replace them with increased intake of either of the following foodstuffs: beans or other grain legumes, fish, groundnuts or meat.
This is unsatisfactory as far as the farmers are concerned as they normally take these sauces in conjunction with the indigenous vegetables.

3.7 Water resources and irrigation

3.7.1 Water availability

Farmers rely mainly on rainfall to irrigate their crops. However, one of the research teams visited one farmer who had an extensive farming system with fields that are connected by means of irrigation channels. A nearby spring feeds these channels. Most farmers, however, have wells on their land, which are used for household consumption and for irrigation in the dry season. According to farmers, the supply of water from these sources may fluctuate during the dry season. During the rainy season, from March to June and again from August to December, the rainfall in most years is considered sufficient for indigenous vegetable production. Farmers have observed that in recent years there are times when they get too much rainfall during the rainy season. This damages crops and washes some away. During the dry season, they receive virtually no rainfall. Farmers complained that sometimes this resulted in crops withering and dying. Farmers draw water from wells, boreholes and springs (Table 13) to irrigate their indigenous vegetables, during the dry season.

Table 14: Major water source and utilization

District	Water source	Utilization
Hoima	Wells, springs, boreholes, rainfall	Household use, irrigate crops
Mbale	Wells, springs, boreholes, rainfall	Household use, irrigate crops
Mbarara	Wells, springs, boreholes, rainfall	Household use, irrigate crops
Mpigi	Wells, rainfall	Household use, irrigate crops
Lira	Boreholes, swamps, rainfall	Household use, irrigate crops
Rakai	Wells, boreholes, rainfall	Household use, irrigate crops
Soroti	Boreholes, swamps, rainfall	Household use, irrigate crops
Tororo	Wells, boreholes, rainfall	Household use, irrigate crops

Some farmers observed that when such water was used to irrigate crops during the dry season, it did not help the situation. The local perception is that rain-fed indigenous vegetables tend to grow better and faster in comparison to irrigated ones. This is probably the result of a number of factors:

- The plants clearly receive less water when irrigated in the dry season because of the amount of extra labour required to fetch irrigation water. The daily activities for the household do not indicate fetching irrigation water but only fetching water for household consumption. A lot of water will have to be fetched in order to equal the amount that plants receive in the rainy season. Irrigation activities take up time for in most cases it is done manually and is a long process. Time must be taken from other necessary agricultural and household activities during the dry season so that irrigation can be carried out.

- Farmers noted that in some cases the irrigated plants tend to change colour and this is especially the case when a lot of irrigation water is applied. The water from different sources needs to be analysed as the chemical content of this can be affecting the soil nutrient balance around the plants.

The reliance on rain-fed irrigation is extremely high and believed generally to be taken for granted and farmers did not indicate the practise of irrigation in the steps required to cultivate indigenous vegetables nor did they allocate anytime for this in their daily time clocks.

3.7.2 Water harvesting techniques

Some of the farmers visited during the transect walk had rainwater tanks next to their houses which were rain-fed by means of down pipes attached to the gutters on the roof of their house. Others have wells or springs on their land. In the case of the latter these can also be on neighbouring land and the fields are fed by a number of irrigation channels. Most farmers travel to a well or spring and collect water in plastic jerry cans. It seems that most water from wells, springs, boreholes and rainwater tanks is used primarily for household purposes. Mulching is used to reduce water evaporation and control weeds and is used for indigenous and exotic vegetables as well as a number of other crops in some of the areas visited.

3.7.3 Irrigation practices

Most farmers irrigate using plastic jerry-cans filled with water which they sprinkle onto the plants using grass/thatch brushes. A few farmers use irrigation channels. Sometimes they irrigate the fields by means of flood irrigation and sometimes they follow the more common practice of sprinkling the water on to the plants with grass brushes. Farmers do not distinguish among the different types of indigenous vegetables or between indigenous and exotic vegetables when discussing irrigation practices. They are aware of the difference between crops that receive channel irrigation and those that receive manual irrigation. The former seem to develop better probably due to enough water being provided. The amount of water given to the plants on a manual basis is minimal as the labour involved in collecting the required amount of water and carrying out the irrigation is significant. Consequently this minimal irrigation has no real effect and in some cases if too little is applied then the crops in fact do worse. According to the farmers adequate irrigation is very important to ensure that the plants grow optimally, this is at its best during the rainy season.

Some farmers dig terraces, which are used as footpaths between their fields on the slopes and make ridges around plants to conserve and control water run-off in gardens and fields. Paspanema grass is planted along field borders to prevent erosion and control the run-off of water out of the gardens and fields.

Important research areas worth considering here include drought resistant varieties that will also grow optimally during the rainy season and ways of conserving enough water to meet both the agricultural and household needs of the farmers during the dry months. Actual water use and irrigation trends need to be studied in detail if further research on these crops, in order to get an accurate idea of when and how irrigation should be carried out. Possibly changing the times of the day when plants are irrigated might have more effect when the water sources are improved.

3.8 Soil preferences, conservation and effect on indigenous vegetables production

The country has a range of different soils that include sandy soils, clay soils, and loam soils. The farmers and extension officials considered the local soil to be infertile and of extremely poor quality. The reasons for this were given as over use of the land. In some cases the land was formally under tropical forests, which quickly loses depth and fertility under agricultural production. Sampling was done in three of the districts and analysis of the soil structure and nutrient content carried out. The results are presented in Table 15.

Table 15: Soil analysis results for indigenous vegetable gardens

Area	Vegetable	Soil sample	PH	% OM	% N	Av. P % PPM	Mg/100g soil				Sand	Clay	Silt
							K	N	Ca	Mg			
Tororo town	Jobbyo	0 – 15 cm	6.6	2.81	0.03	7.96	0.44	46	3.11	0.79	74.0	10.0	16.0
		0 - 15.30 cm	6.4	1.36	0.03	5.25	0.24	0.31	2.98	0.77	76.0	14.0	10.0
Tororo upcountry	Sukumawik (Kale)	0 – 15 cm	7.6	1.84	0.10	25.32	1.16	1.15	8.57	1.6	76.0	14.0	10.0
		15 – 30 cm	7.6	0.68	0.07	20.19	0.52	0.53	3.57	0.6	8.20	8.0	10.0
Tororo upcountry	Marakwang	0 – 15 cm	7.2	0.87	0.03	81.98	0.19	0.23	2.46	0.74	88.0	8.0	4.0
		15 - 30 cm	7.4	0.68	0.03	44.10	0.19	0.15	1.99	0.37	86.0	8.0	6.0
Mpigi	Nakati	0 – 15 cm	7.3	5.57	0.13	19.71	1.48	1.38	9.42	3.25	64.0	12.0	24.0
Mpigi	Bugga	0 – 15 cm	6.4	7.02	0.27	13.78	0.52	0.54	7.1	2.52	56.0	10.0	3.40
Mpigi Ggalabi	Nsugga	0 – 15 cm	7.2	5.81	0.10	16.12	0.96	1.15	8.5	4.26	66.0	200	14.0
Rakai	Bugga	0 – 15 cm	7.1	7.5	0.27	54.76	2.6	2.53	16.9	4.2	68.0	16.0	16.0
Rakai	Nakati	0 – 15 cm	6.7	6.9	0.20	48.67	1.3	1.3	11.21	3.61	68.0	18.0	14.0

Loam soil is the preferred soil especially that which is high in organic content for most agricultural production systems. The soils on which the indigenous vegetables wee found growing were in the neutral pH range of 6.4 – 7.6 with fairly high organic matter, nitrogen, phosphorus and potassium. These soils were, therefore, on the fertile side for agricultural production purposes. Some farmers visited practised mulching and had areas set aside for composting to overcome this soil infertility.

Farmers indicated that indigenous vegetables do not deplete the soils but instead help in maintaining the nutrients in the soil. Most farmers do not rest the land but manage the cultivation of indigenous and exotic vegetables so that inputs such as manure and some plant residues remain in the soil or are reintroduced by ploughing the plant residues back into the soil at the end of each season. Indigenous vegetables are rotated with other crops including exotic vegetable crops. Specific indigenous vegetables are said to be particularly beneficial to soil for example grain legumes such as beans have nitrogen-fixating properties and add nitrogen to the soil. Companion planting/intercropping is sometimes done because of the belief that different crops aid each other, improving mutual performance.

3.9 Market trends

Most of the farmers who sell their produce do so to traders in urban or trading centres. This is usually done during peak harvest periods. Consequently the supply is more than adequate so the traders tend to lower the purchase price they offer the farmers. Storage facilities and other means of preserving and storing the crops until the demand and prices improve are unavailable. This largely explains why prices widely fluctuate (Table 16).

Table 16: Marketing and pricing of indigenous vegetables

Indigenous vegetable	Place of sell	To whom	Price
Amaranthus dubius	Urban and rural trading centres	Traders and consumers	2,000-10,000 /= per bundle
Amaranthus blitus	Urban and rural trading centres	Traders and consumers	5000-1500/= per bundle
Vigna unguiculata	Urban and rural trading centers	Traders and consumers	
Solanum anguivi	Urban and rural trading centres	Traders and consumers	3000-5000/= per measure
Cloeme gynandra	Urban and rural trading centres	Traders and consumers	200-2000/= per bundle
Solanum aethiopixcum	Urban and rural trading centres	Traders and consumers	4000-70000/= per bundle
Solanum gilo	Urban and rural trading centres	Traders and consumers	2000-20000/= per measure
Hibiscus sabdariffa	Urban and rural trading centres	Traders and consumers	2000-5000/= per bundle

The farmers have no choice but to sell the produce to the traders at the ruling prices or throw it away. To cover the travelling and surplus production costs the farmers must sell irrespective of the price. Produce is usually transported to markets in large bundles and sorted into smaller bundles for sale (Plate 3).

Plate 3: Market vendor sorts vegetables into smaller bundles for sale (left), small bundles of bugga (*Amaranthus blitum*) ready for sale (right)

3.9.1 Marketing/sales problems

It was noted that indigenous vegetable farmers do not have any formalised marketing strategy and rely heavily on the terms dictated by the market and the consumer demand for their vegetables and factors such as seasonality. If there is abundance of indigenous vegetables at the market, the farmers ended up throwing away their unsold quantities. This problem is at its worst during peak harvest time for *Solanum aethiopicum* and *Amaranthus blitus*, which occurs during the rainy seasons. Farmers suggested that their indigenous vegetables could be processed to increase shelf life so that vegetables could be stored for longer periods until the market demand was available.

A market demand survey would indicate which processing system would be a viable option.

4.0 RECOMMENDATIONS

On the basis of the farmers information, results of discussion groups and the researchers observation during the transects walks, a conceptual framework of activities needed to address indigenous vegetables continuum from production to consumption constraints was constructed and is presented in Fig. 1.

It is recommended that this conceptual framework be executed with the full participation of the farmers, traders and consumers. This will take advantage of indigenous knowledge during technology development for production, processing and preservation of indigenous vegetables. A participatory system will also increase the likelihood of adoption of solutions by the stakeholders.

Regular visits to the districts will be necessary in order to observe precisely what improved technologies the farmers in the cultivation of indigenous vegetables are implementing and precisely how the different vegetables are being used. This will become especially important if the increase in cultivation and utilisation of indigenous vegetables follows the adoption of improved technologies. With extra help, it is likely that local farmers could become innovative. If this happens then there would be need to encourage it and share the information.

There is need to capture all the different names of all the different types of indigenous vegetables that were reported to accurately identify them. This will be of use in the conservation efforts. Where plants are similar to exotic counterparts or come from the same family, they should be compared for nutrient content and hardiness to constraints to determine which is the most suitable for the local farmers. Preference will have a role to play in this and possibly breeding can be done to maximise preferred qualities.

5.0 REFERENCES

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Fig. 1: Conceptual framework for African indigenous vegetables research in Uganda