CROP POST-HARVEST PROGRAMME

Improving the livelihoods of peri-urban vegetable growers through market promotion of fresh and processed indigenous vegetables

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FINAL TECHNICAL REPORT

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Contents

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Abbreviations and glossary

CPHP – Crop Post-Harvest Programme
CTDT - Community Technology Development Trust
DTC - Development Technology Centre
HRC – Horticulture Research Centre
NGO - Non- Government Organisations
NRI – Natural Resources Institute

Traditional Vegetable Crops Utilized in Zimbabwe

English Name	**Scientific Name**	**Vernacular Name**
Spider flower	*Cleome gynandra*	*Nyevhe*
Lady's finger/okra	*Abelmoschus esculentus*	*Derere rechipudzi*
Pumpkin leaves	*Cucurbita moschata*	*Muboora/Mumhodzi*
Cow pea leaves	*Vigna unguiculata*	*Munyemba*
Indian kale,	*Brassica juncea*	*Tsunga-Zifodya*
Jute	*Corchorus olitorius*	*Derere-nyenje*
Jute	*Corchorus trilocularis*	*Derere-regusha*
Bottle gourd	*Lagenaria siceraria*	*Mapudzi*
Horned cucumber	*Cucumis metuliferus*	*Magaka*
Amaranths	*Amaranthus spp.*	*Mowa*
Mushroom	(Wild and local)	*Chowa/Howa*

Executive Summary

This final technical report presents the findings of the project 'Improving the livelihoods of peri-urban vegetable growers through market promotion of fresh and processed indigenous vegetables' conducted in Zimbabwe. The aim of the project was to improve food security and livelihoods of poor households through increased availability and improved quality of fresh and processed indigenous vegetables (IVs) and better access to markets. The project would target farmers, processors and traders of traditional vegetables in and around Zimbabwe's major cities and increase food security for its residents. The project will address the need to improve the quality of fresh and processed African vegetables in order to expand market opportunities of these commodities.

The literature review and two series of market surveys completed in three urban centres, Harare, Bulawayo and Mutare and their peri-urban areas confirmed the increasing role of indigenous vegetables in food security, as both a food source and income, for the poorest people. Women dominate both cultivation and trading. They do not require large capital investment to produce or trade; production systems are short and labour intensive. They are an important source of nutrition for poor urban households, because their prices are affordable relative to other food items. They are well suited to providing a source of leafy vegetables from August to December, a period of scarcity, however, supply is not meeting demand. It should also be noted that trading of IVs has spread to higher income groups and retail outlets, including supermarkets. However, the surveys raised constraints in cultivation and trading, related to lack of seed, low productivity, high perishability and poor quality of processed products (mostly dried leaves). Priority crops were identified for further studies as outlined below.

Based on the surveys and other sources of information, improvement programmes were undertaken on cowpea, bottle gourd, Corchorus and Cleome (spider plant). The on-station trials on Corchorus and Cleome focussed on plant establishment, leaf harvesting method and yield. Planting out seedlings was found to increase yields for Corchorus (nine-fold) and Cleome (twofold) compared to the normal practice of broadcasting seed. Transplanting also significantly increased seed yields. Harvesting by completing removing the whole plant stand above the second node increased leaf yield threefold and seed yield (sevenfold) compared to harvesting the tips.

Post-harvest handling research of bottle gourd showed that cold storage maintained fruit quality better than polymer coating, and that harvesting 15 days after fruit set produce the best quality gourds. The project has been working with the Crop Breeding Institute to develop promising dual-purpose varieties of cowpeas that produce both beans and leaves for consumption. The project has supported nutritional analyses of the leaves and has evaluated that the economic returns are greater when harvesting both beans and leaves (fresh and dried) particularly for newly developed 'dual purpose' varieties.

Surveys indicate that there is a high demand for dried vegetables, particularly from cowpea, Cleome and pumpkin, even though quality and packaging need improving. Most of the leaves are processed by sun drying. Several organisations are currently adapting solar drying technology to produce dried leafy vegetables. The Project

collaborated with the Development Technology Centre of the University of Zimbabwe to refine and disseminate the technology. Processing charts and quality control guidelines have been compiled for cowpea, Cleome and pumpkin (in English, Shona and Ndebele). The benefits and costs of drying determined the minimum price (100 Zim. $ per cup) for breakeven. Training programmes have been developed and implemented. Two dryers have been built and set up for demonstration programmes in Harare and Bulawayo, working with groups of local farmers/processors.

The promotion and dissemination has centred on the seed/germplasm, crop management and processing outputs of the project. The uptake of new germplasm produced by the project has aimed to develop effective seed delivery systems accompanied by appropriate knowledge. The project is currently disseminating seed to farmers through the Horticulture Research Centre and a private seed company (East-West Seed) for Cleome, Corchorus, Brassicas and Okra, and through the Department for Research and Specialist Services for cowpea. The dissemination of the improved cowpea varieties was accompanied by a national field day at Matopos Research Centre with press and TV coverage. The distribution of seed is accompanied by information on the commodities. Technical booklets and farmer leaflets have been prepared for dual-purpose cowpea, Cleome, Corchorus, Brassica, okra and bottle gourd. As indicated above for processing outputs, demonstration equipment and leaflets have been completed.

The outputs of the project have mostly been achieved with the principal vegetable types, as identified by the surveys, being assessed and seed disseminated. However, for reasons outside of the project's control, the project was not able to disseminate the findings as widely as possible in Zimbabwe, particularly in rural areas. Associated with this was the difficulty in developing community seed banks and other seed multiplication and distribution systems apart from the public organisations and a major seed company that the project was working with.

Background

Food production, in and around the home, may have started as a survival strategy but increasingly it offers income-generating opportunities, not only for the producers but also for processors, traders and casual labour. The key to sustainable success in peri-urban agriculture is the need to maximise returns from limited asset resources in a relatively insecure urban/peri-urban environment. In the past, this sector has had limited access to capital, technology, government or municipal facilities, the formal market place and links with the formal sector.

This project will address the need to maximise the potential from farming systems utilising indigenous vegetables (IVs) which grow well under rain-fed systems when exotics are relatively scarce and difficult to produce because of disease and input supply constraints.

Vegetables constitute a very important part of the Zimbabwean diet. One can find approximately 25 different species of African vegetables in Zimbabwe of which about ten are frequently cultivated and others are collected from the wild or where volunteer plants develop. Although these crops have undergone some selective pressure, they have not benefited from research and, consequently, there are no uniform varieties but only highly variable landraces. This is a major concern for both farmers and traders.

Needs assessment studies conducted by NRI in Zimbabwe, funded by the CPHP[1], identified that market wholesalers and retailers considered the poor quality of fresh produce to be a major constraint. This is related to a number of factors including heterogeneous crop characteristics, pest and diseases on harvested commodities, short shelf life, poor post-harvest handling and lack of awareness of quality criteria in the market. Workshops dealing with traditional crops have been held in several locations in Africa, including those organised by the International Centre for Under-utilised Crops, the International Plant Genetic Resources Institute and local non- Government Organisations (NGOs) as well as universities and national research stations. In a seminar, organised by Zimbabwe's Community Technology Development Trust (CTDT) in September 1998, a baseline study reported that farmers and traders had identified the need for improved post-harvest handling and marketing of traditional vegetables. Farmers and processors have further recognized the need to reduce losses through improved drying technology and packaging, and to develop a more effective marketing system.

The awareness raised by the above seminar and other studies has led to a change in research policy in Zimbabwe where indigenous vegetables now feature as a priority crop by the country's Horticultural Research Centre.

Highest yields of indigenous vegetables (and lowest prices) occur during the wet season. However, farmers are often forced to sell at very low prices because produce cannot be stored due to its highly perishable nature. Losses during transportation, handling and re-distribution range from 30 to 50% for leafy vegetables, although

[1] Project No. R6674: The identification and development of Crop Post-Harvest Programme research activities in southern Africa.

losses of 100% are common for particularly perishable vegetables such as Chinese cabbage.

Some farmers attempt to preserve the value of the crop through traditional sun drying techniques. However, the quality of the dried products, particularly leaf vegetables, is compromised by poor drying conditions, poor hygiene, inadequate storage conditions and by insect and fungal attack. However, surveys indicate that there is an increasing demand in urban centres for ready-made foods such as dried and ground vegetables to be used as ingredients in soups and sauces. Development and dissemination of appropriate technologies to improve the quality and shelf life of dried vegetables would provide opportunities to meet this urban demand.

The aim of the project is to develop varieties with appropriate characteristics and post-harvest handling and processing technologies to supply both the quality and quantity required by the urban markets on a year-round basis.

Project Purpose

The project aims to develop strategies which improve food security of poor households through increased availability and improved quality of fresh and processed indigenous vegetables and better access to markets. The outputs will aim to improve the livelihoods of farmers, processors and traders of indigenous vegetables in and around Zimbabwe's major cities and increase food security for its residents. The project will address the need to improve the quality of fresh and processed African vegetables in order to expand market opportunities of these commodities. The selection of improved varieties, based both on improved marketability criteria and productivity, is expected to make a significant impact on their commercial potential (both fresh and processed) compared with the diversity in quality seen in the landraces currently being marketed. New post-harvest handling and processing techniques identified and developed could extend the marketing season to a year-round activity. This is expected to provide employment and income generating opportunities for many farmers, processors and small-scale retailers in both the formal and informal sector.

Output 1: Characterisation of IV commodity systems and assessment of market potential for fresh and processed vegetables

The objective of the socio-economic survey was to collect information in order to characterise and document the indigenous vegetable system from producers through to consumers.

Surveys were undertaken in the urban and peri-urban areas of Harare, Bulawayo and Mutare. Semi-structured interviews, with checklists were conducted with representative groups and individuals. For example, in Mutare a range of traders, from wholesalers to street vendors, was interviewed as indicated in Table 1.

Table 1. Types and number of indigenous vegetable traders interviewed in the urban and peri- urban areas of Mutare

Type of trader (s)	**Location**	**Number of people interviewed**		**Total number**
		Male	Female	
1.Stallholders	Sakubva Musika	2	11	13
	Chikanga		1	1
(i) Individual	Sakubva Residential		1	1
	Fairbridge Park		2	2
	Greenmarket	1		1
	Dangamvura		2	2
Total				20
(ii) Group	Sakubva Musika		1 (9)*	9
	Chikanga		1 (2)	2
	Sakubva Residential		1 (2)	2
	City Centre		3 (7)	7
	Honde Valley		2 (5)	5
Total				25
2. Wholesaler & Producer				
i) Individual	Sakubva		3	3
	Chitakatira		1	1
ii) Group	Chitakatira		2(11)	11
Total				15
3. Producer and Stallholder				
i) Individual	Nyanyadzi		1	1
ii) Group	Rowa		1 (2)	2
Total				3
4. Street Vendor				
i) Individual	City Centre		1	1
ii) Group	Dangamvura		2 (8)	8
Total				9

* The numbers in brackets represent the total number of people in the groups interviewed.

The surveys focused on each of the groups (traders, consumers and producers/collectors) separately. The survey was carried out over a fortnight in February – March 2000, when it was expected that most of the indigenous vegetables would be on the market and repeated during 2002 to confirm findings.

The findings from the survey are presented separately for each group of stakeholders. These groups are:

PRODUCERS & COLLECTORS
CONSUMERS
TRADERS.

Information was also gathered through literature reviews of published and grey literature.

Results

It is important to understand the terms traditional and indigenous in relation to vegetables. The terms traditional and indigenous are sometimes used loosely or interchangeably. From a research perspective indigenous vegetables are crops or plants that have evolved naturally within the confines of the boundaries of Zimbabwe. Examples include cowpeas, spider plant, Amaranthus, Jew's marrow, and many other plants. Many of these plants are common and utilised in many African countries. As the culture is similar in most African countries so are the eating habits, which are also influenced by other factors like climate. This broadens the definition of indigenous crops/plants to include all crops/plants cultivated or gathered from the wild or are known taxonomically to be from Africa. These would include okra, Ethiopian mustard and African eggplant (not very common in Zimbabwe). Hence the most important food crops from the African point of view are traditional vegetable crops.

It has become evident from the literature and observations that there is genetic erosion occurring in many varieties of traditional crops, despite their nutritional and cultural contribution to millions of people during both good and hard times.

Farmers

The majority of producers and collectors are women:

- Bulawayo - 60 % of those interviewed were women;
- Harare - 42 % female;
- Mutare – 90 %.

Three main reasons were given as to why traditional vegetables are cultivated:

- for domestic consumption as well as for income generation;
- low production costs when compared with other crops;
- for medicinal purposes, for example, black jack is cultivated to treat various stomach ailments.

A range of traditional crops are cultivated or collected (Table 2).

Table 2. Traditional vegetables cultivated or collected according to importance (ranking was based on the perceptions of the interviewees).

Ranking	**Bulawayo**	**Harare**	**Mutare**
1	*Cleome*–	Pumpkin leaves	Pumpkin leaves
2	*Corchorus*	Okra	Okra
3	*Cowpea leaves*	Spider plant	Spider plant
4	Pumpkin leaves	Indian kale	Black jack
5	*Gourd*	Cowpea	Corchorus
6	Okra	Jute marrow	Amaranth
7		Amaranthus	African cucumber
8		Bottle gourd	
9		African cucumber	
10		Wild gherkin	
11		Water melon	

The cultivation and collection of most traditional vegetables is concentrated in the major wet season, which normally runs from November to March. Thus in Mutare the harvest periods for each crop is mostly within this period as shown below (table 3).

Table 3. Production and collection period for traditional vegetables in Mutare.

Vegetable	**Harvest/Collection Period**	**Status of Production**
Corchorus	Nov – Feb, all year round in Chitakatira/Chigodora	Collected
Lady's Finger	Nov – Feb, all year round in Chitakatira/Chigodora & Nyanyadzi	Cultivated
Pumpkin leaves	Dec – May, all year round in Nyanyadzi, Honde Valley & Chitakatira/Chigodora	Cultivated
Spider Flower	Dec – Feb	Collected
Mushroom	Dec – Feb	Collected
Cucumis anguria	Jan - Mar	Collected
Amaranth	Dec - Feb	Collected
Ngaka	Dec – Feb, all year round in Nyanyadzi & Honde Valley	Collected & cultivated close to river banks
Sweetpotato leaves (*Kowa)*	Dec – Mar, all year round in Nyanyadzi and Honde Valley	Cultivated
Black jack	Dec – Apr, all year round in Honde Valley & Chitakatira/Chigodora	Collected
Galinsoga parviflora	Dec – Mar/Apr, all year round in Chitakatira/Chigodora and Nyanyadzi	Collected

All of the semi-cultivated traditional vegetables, such as cowpea and pumpkin were intercropped with other crops such as maize and beans. Seeds were sown randomly between the rows of the main crops.

Those collected were often picked from plants that had invaded cultivated land where they volunteer as weeds. Collections could also occur in the wild or close to rivers in the drier part of the year.

Okra on the other hand was reportedly produced under monoculture conditions: no producers reported intercropping okra. Women largely carried out cultivation of traditional vegetable crops such as spider plant. The men concentrated on those traditional vegetables, such as okra and pumpkin leaves, which require more attention. Men did not appear to participate in collection from the wild.

Farmers noted an increase in demand for traditional vegetables over the last three years with producers responding by increasing production/collection to satisfy the market demand, although there was a perception that they were not fully meeting the demand. The producers themselves reported that in general they had not increased their own consumption of traditional vegetables. Most producers consumed traditional vegetables up to five times per week of those that would be in season. In the wetter areas, the seasons could be longer and consumption was about three times per week. About 80% of those interviewed consumed traditional vegetables at least

twice per week, and all members of the family would consume. Those traditional vegetables mostly consumed were spider plant, okra, pumpkin leaves and Black jack.

Data for how much the farmers sell were not very easy to get. Only a few farmers were able to provide information on how much they would sell at the market per day (Table 4).

Table 4. Amounts and Prices of Traditional Vegetables at the Market in Harare

Vegetable	**Farmer 1**	**Farmer 2**	**Farmer 3**
Cleome	36 bundles	36-48 bundles ($15.00)*	12 bundles ($2-$10)
Pumpkin leaves	84 bundles	36-60 bundles ($5-7)	-
Okra	-	$200/box	$150- $300/box
Corchorus	-	24 bundles	

*Prices in brackets are per bundle

In general farmers did not keep any records on amounts sold or value so that it was not possible to rank traditional vegetables in terms of their economic worth.

Farmers did not directly use any inputs, such as fertilizers and pesticides, on traditional crops but would do so for their main crops.

All the farmers said they retain their own seed for most if not all of the traditional vegetables they grow. For example, in the Harare area, sources of seed were variable and depended on the crop:

a. Spider flower - only the Esigodini and Matobo producers mentioned deliberate seed harvesting. There was no mention of variety selection.

b. *Corchorus* sp - no deliberate action to preserve planting seed is taken, with natural self-seeding a feature.

c. Cowpea - seed is obtained from the previous crop and communities give each other seed. In some areas around Harare, improved varieties introduced by NGOs and some government agencies are dwarf and high yielding in terms of the beans, but with lowered leaf yields which are as important to the farmers as the beans.

d. Pumpkin - as for cowpea.

e. Butternut squash - bought from seed shops.

f. Gourds - as for cowpea.

g. Okra - bought from seed shops or retained by farmers.

Processing and Storage of Traditional Vegetable Crops

Most producers undertake some processing. Processing and storage is a task usually done by women. The most common method of processing is blanching of the

vegetables in boiling water and sun and /or air-dried. The duration of drying depends on individual preference and taste.

Cowpea leaves, which are mostly marketed in the dry form, are cooked for some minutes. When the pot has cooled down the vegetables are then drained and as much water as possible squeezed out by hand before being spread out directly on to a clean surface e.g. a swept flat rock. Others place the vegetables in containers or on plastic sheets, spread thinly to facilitate quick drying.

Traders

Surveys in a range of markets and trading places in Harare, Bulawayo and Mutare showed that mostly women traded in traditional vegetables. Spider plant leaves were the most popular of the traditional vegetables traded (Table 5).

Table 5. Traditional vegetables traded in Harare, Mutare and Bulawayo.

Commodity	**Mutare**		**Harare**	**Bulawayo**
	Fresh	Dried	Fresh	
Okra	X* (1)**	2	X (4)	X
Spider Plant	X (2)		X (1)	X (1)
Pumpkin leaves	X (3)	3	X (2)	X
Black jack	X (4)			
Corchorus	X (5)	4	X	X
Cowpea leaves	X	1	X (5)	X
Amaranth leaves	X (6)		X	X
Indian Kale	X		X (3)	
Nightshade	X			
Gallant soldier	X			
Horned cucumber	X		X	
Indian mustard	X			
Ethiopian mustard	X			
Gourds	X		X	X

* X – denotes that the commodity is traded.

** - where given, the value in parenthesis denotes perceived order of importance.

Trade in traditional vegetable crops followed a specific pattern. For fresh vegetables trade commenced soon after the first rains (around mid-November) until April/May period when winter begins. Best prices are achieved at beginning and end of the wet season. *Cleome*, *Amaranthus* species and Corchorus *sp.* would be the first to be available as they are triggered by the first rains and grow as weeds (Table 6 shows trading pattern in Mutare). Other cultivated vegetables crops like cow pea, pumpkin leaves, okra and gourds appear later after being planted. These are commonly cultivated as rain-fed crops. Soon after the fresh produce is finished, traders increased their activities in dealing with processed (dried) vegetables, in most cases, of the same type except *Amaranthus* species, which was never found in dried form.

Dried produce is traded all year round (although it is unusual to find traders who specialised in dried produce). It is evident that fresh vegetables are more important for the local market while the dried vegetables especially cowpea leaves and spider

plant have a high potential for expansion on the export market to neighbouring countries or locally for off-season supplies. Supply was not meeting demand for most traders. The mushrooming of street-corner and roadside vending markets that happen to be more accessible to consumers was mentioned as a major contributing factor to increase in trade.

Table 6. Quantities of Traditional Vegetables Traded in Mutare.

Vegetable	**Condition F - Fresh D - Dried**	**Trading Period**	**Quantities sold per trader**	**Type of trader**
Lady'Finger/*Nyatando*	F	Jan-Dec.	1-4x20l tins/day 5-50pkts/day	Wholesaler Stallholder
	D	May-Nov.	5-10pkts/day	Stallholder
	D		5-50pkts/day	Stallholder
Spider Flower	F	Oct.-April	5-20 bundles/day	Stallholder
			4x50kg bags/wk	Wholesale
Pumpkin leaves	F	Nov-May	2-20 bundles/day 50-70 bundles/day	Stallholder Wholesaler
	D	May-Oct.	5-10pkts/day	Stallholder
Black jack	F	Oct-April	2-20 pkts/day 3 x 50 kg bags/wk	Stallholder Wholesaler
Cowpea leaves	F	Nov-March	5-15pkts/day	Stallholder
	D	April-Oct.	5-10pkts/day 1 x 20L/wk	Stallholder Wholesaler
Amaranth leaves	F	Nov-March	1x20l/wk 15pkts/day	Wholesaler Stallholder
Mushokoni	F	Nov-Feb.	15pkts/day	Stallholder
Cleome monophylla	F	Nov-Feb.	15pkts/day	Stallholder
Nightshade	F	Nov-Mar	15pkts/day	Stallholder
Galinsoga parviflora	F	Nov-Mar.	15pkts/day	Vendor, Stallholder
Cucumis anguria	F	Nov-March	15pkts/day	Stallholder
B. juncea sp (Muchakupuka)	F	All year	15pkts/day	Vendor, Stallholder
Ethiopian kale/mustard	F	Mar-Oct.	15pkts/day	vendor, stall
Mushroom	F	Dec.-Feb.	20-50 portions/day	Vendor, Stallholder
B. juncea	F	Oct-Feb.	14x50kg bags/wk	Vendor, Stallholder

Although it became apparent that trade in traditional vegetables was quite significant, traders could not establish the numerical quantities of produce they handled, whether dried or fresh. No standard measurements were used and this could have discouraged traders from keeping sales records. This made quantification of sales very difficult, if not impossible.

Pricing was guided by demand. Prices were decided for a certain estimated quantity of produce (a heap and bundle of fresh traditional vegetables) and by volume for dried vegetables. The size of the heap for fresh vegetables was estimated by the naked eye while the number of leaves determined a bundle size. For traditional vegetables sold

in heaps, prices were normally the same despite type and variety differences. All the traders mentioned that the bundles are smaller both at the beginning and end of the rainy season because of scarcity. However the size gradually increases until mid-December and January when the market is flooded with fresh traditional vegetables. In one market in Bulawayo, the volumes for sale were weighed to gauge the relative prices of produce being sold:

Dried *Cleome*	410 g
Dried cowpea - loose leaves	240 g
Dried cowpea –lumps (moulded) of leaves	430 g

All the above products were being sold at Z$50 but note the differences in weights.

Wholesale traders bought traditional vegetables from peri-urban and rural farmers. Where good transport existed, villages as far away as 240 km supplied urban markets. Transport to the market is usually by public buses. These buses usually charge a certain additional fee per produce container. Long distance charges ranged between Z$5.00 and Z$30.00 per 91 kg bag of traditional vegetables. However, public transport can be unreliable especially during the rain season that coincides with the peak of traditional vegetable. Other forms of transport that are used include 'kombis' and privately hired pick-ups.

Consumers

Consumers' preferences varied from one survey to the next but the most popular traditional vegetables were spider plant leaves, blackj jack, corchorus, pumpkin leaves, okra, and amaranths.

Traditional vegetables were consumed for several reasons:

a. taste was discovered to be the most influential attribute that affected consumption levels of traditional vegetables;

b. availability - households with larger families find that traditional vegetables play a pivotal role in providing for household food security in both urban and rural areas;

c. affordability - the cost of meat, milk and exotic vegetables was getting out of reach of many people hence the switch over to traditional vegetable crops;

d. easy and cheap to prepare requiring few additives, in the poorest cases only salt is added and at times cooking oil.

Some traditional vegetables mentioned during the study grew as weeds although some such as jute and spider plant are managed after emergence (semi-cultivated). This aspect of voluntary growth made some traditional vegetables readily available to almost all households with access to arable and grazing land. The way they are

accessible and available seems to be an important factor in influencing consumption levels of all traditional vegetables. It should also be noted that trading of IVs has spread to higher income groups and retail outlets, including supermarkets.

Constraints

During the surveys, constraints and needs were raised by all groups. The following areas were the common themes.

Cultivation

Seed and Varieties
Availability of reliable quality seed and seed sources was identified as one of the most limiting factors to increased production of traditional vegetable crops.

Most farmers are relying on unimproved landraces using self retained and shared seed. In other cases they rely on natural emergence of crops including spider plant and *Corchorus* species. All the farmers interviewed, who are also traders, expressed a wish to have seed in order to plant off-season so they can make money when there is limited supply. In addition, the seed currently available is variable in qualities such as germination or lacks the required characteristics e.g. improved cowpea varieties.

Within each traditional vegetable group, no distinct varieties are available. Therefore an increase in diversity would expand market opportunities and give consumers a greater choice. Farmers expressed disappointment with the inconsistency found in pod production of some of their landraces.

Knowledge
Information is not available or reaching farmers on improving agronomic practices in areas such as the use of fertilizers and manure, optimum spacing, harvesting and productivity and water usage. In particular, there is a big demand for off-season traditional vegetables but lack of understanding of cultivation practices e.g. water and fertilizer requirements, and lack of seeds is hindering this opportunity for commercial expansion.

Post-Harvest Related Needs (Processing, Packaging and Storage)
Farmers and processors were looking for cheap, improved and easy-to-adopt post harvest technologies for traditional vegetables. These should include processing and storage technologies.

Alternative products and the potential of export markets were areas that required more research and development: currently dried cowpea and spider flower leaves are being informally exported to neighboring countries while dried wild mushrooms are being exported formally to Europe.

Marketing Related Needs

Traders felt that the market infrastructure was inefficient and lacking in basic hygienic facilities, particularly during the wet season

The high cost and unreliability of suitable transport was seen as a major constraint to the trading of fresh vegetables. In some areas the state of the road reduces, transport availability as well as it affects quality of produce.

Lack of marketing information as well as book keeping knowledge and record keeping as a tool for planning were seen as a constraint in business development and management. This was very evident when farmers, traders and consumers were asked to quantify in terms of how many kilograms they sell or profits they make.

Consumer Related Needs

Consumers would like to see an increase all year-round availability of fresh traditional vegetables, which are currently limited to only the wet season (two to three months for *Cleome gynandra* and *Corchorus* species). Lack of consumer knowledge on the preparation and use of traditional vegetables is restricting market expansion. .

External Support Services

There was evidence that external assistance as regards production, marketing and consumption information was very limited. With the exception of those few farmers in contact with the Community Technology Development Trust (CTDT), most farmers and processors are not aware of the simple drying facilities as well as the nutritional advantages of utilising traditional vegetables. Extension services do not have relevant information or materials to disseminate.

Output 2. Varieties of specific vegetable crops with improved marketability selected and bred.

During the surveys, it was noted that the availability of planting material (seed) was a major limitation to increased exploitation of traditional vegetable production, marketing and consumption. Farmers were particularly keen to cultivate traditional vegetables out-of-season to meet consumer demand.

Some traditional vegetables including Corchorus and spider plant are harvested from wild or are volunteer plants that germinate with the onset of the rains, whilst other vegetables are cultivated from farmer-saved seed or seed obtained from neighbours that is broadcast directly as an intercrop. In all cases, seed quality is very variable and is of unknown viability. Most of the cultivated vegetables are local landraces that consist of mixtures of different types of the same vegetable. For example, in a population of Spider plant, a mixture of purple stem and green stem plants can be easily seen. While variability is an added benefit in some instances, it may be important to select for superior types (in terms of desired attributes) within the local landraces as well as introduce improved types (if any) from other African countries where the vegetables are utilized.

Since there is only seed of a few vegetable types e.g. okra, it is very difficult to expand and improve productive potential because of inadequate planting material. Even, where some improved seed is available, the characteristics are not necessarily that required by the farmers, for example new improved dwarf determinate varieties of cowpea are being disseminated by some NGOs, especially after droughts when they are given out as drought relief packs. These improved varieties give very high grain (pulse) yield but low leaf yield. However, most farmers prefer dual-purpose varieties but not much research has been targeted at developing this type of varietal characteristic.

The most popular traditional vegetables, the leafy types, are harvested by regularly removing leaves throughout the rainy season once the plant has reached a certain stage of development. Farmers cited particular problems in sourcing labour for harvesting, as there was competition for labour with other field crops. It is not known whether reduced harvesting periods would affect yield.

Another constraint identified was the short shelf life of traditional vegetables. At most, leafy vegetables, especially spider plant, were reported to last for a maximum of 3 days beyond which they started to lose their flavour even if they would still be visibly fresh. Attempts at refrigeration had not yielded positive results as they still lost their flavour within those 3 days. Freshness also rapidly deteriorated in transit from the production areas and at the wholesale and retail markets. Attempts at maintaining freshness through constantly sprinkling water does not yield desired effects as well as presenting food safety risks.

The non-leafy vegetables including the gourds, pumpkins and horned cucumbers also suffer from post-harvest deterioration and loss in quality. Knowledge on post harvest handling of the produce including storage methods is very scarce for these commodities.

Farmers appeared to have only limited knowledge on appropriate cultivation techniques and the extension services do not have information to assist farmers. In order to resolve some of these constraints, a germplasm improvement programme was implemented that aimed to:

- produce improved seed of the most popular traditional vegetables: spider plant, Corchorus, okra and cowpea;

- address constraints in productive and market potential, namely:
  - improved plant establishment;
  - optimal harvesting system;
  - prolonged shelf-life (non-leafy type);
  - grain versus leaf yield for cowpea.

The following programme was established.

A. Horticultural Research Centre, Marondera

1. *Corchorus* species:

   - comparison of direct seeding and transplant methods of crop establishment;

   - assess leaf yield potential of two species *C. trilocularis* and *C. olitorius*.

2. *Cleome gynandra*

   - comparison of two different leaf harvesting methods on leaf and seed yield;

   - comparison of direct seeding and transplant methods of crop establishment;

   - seed multiplication.

3. *Lagenaria* - Gourds

   - evaluate germplasm from local lines;

   - research improvements to shelf life.

B Crop Breeding Institute

1. Cowpea

- Economic returns from leaf versus grain harvesting;

- Nutritional composition.

Corchorus Trial

Objectives

1. Compare the two known methods of establishment to see which one gives the best crop stand.

2. Assess the leaf yield potential of two species i.e. *Corchorus olitorius* and *Corchorus trilocularis* under the above treatments.

1. Crop establishment

The first trial was designed to observe the best method of establishment for the two *Corchorus* species through either direct seeding or raising seedlings in nurseries prior to transplanting later in the field.

Seeds of *Corchorus trilocularis* and *Corchorus olitorius* were first immersed in cold, previously boiled, water for 24 hours to break dormancy. The conditioned seeds were then sown in seedling trays.

An emergence assessment 7 days after sowing showed a 2.5 % germination in *Corchorus olitorius* and 1.0 % in *Corchorus trilocularis.* Another count 14 days later, showed *C. trilocularis* 8% germination and *C. olitorius* 39.2%. Germination continued to improve steadily in *C. olitorius* in subsequent days.

With *C. trilocularis* there was extremely very low germination and its stand was further worsened by damping off disease. This species was later removed from the trial because of the few plants left.

Experimental design
A randomised complete block design of 5 plots of 3 x 3 m was allocated to transplants and another set of 5 plots directly sown. Spacing between rows was 0.5 m, with 0.3 m between individual plants.

A basal fertilizer with an NPK ratio of 8-14-7 was incorporated at 450 kg /ha. Top dressing fertilizer with 34,5% N applied at 290 kg /ha split 3 times and applied 3 weeks after emergence.

Results and discussion

Germination of directly sown seed in the field was very poor at 3.5 %, and subsequent crop development soon after emergence was generally very slow. Blended fertilizer boosts of ammonium nitrate, single super phosphate and muriate of potash were administered three times to give the seedlings more vigour.

Seeds continued to emerge as long as the field was watered hence a staggered stand is produced. Due to this prolonged dormancy most seeds will never germinate or will germinate later in the season.

The first flower buds were noticed 5 weeks after germination. In *Corchorus* this does not affect subsequent vegetative development since the plants do not produce the flowers terminally.

Transplants were first harvested two months after date of establishment and continued for two and half months, the directly seeded plants were harvested after two and half months and harvesting continued for two months.

Seed was ready for harvesting after 150 days from the day of sowing and transplanting.

The demand for Corchorus was extremely high as evidenced by the number of local people buying produce from the experimentally plots.

Pests and diseases

Cutworm (*Agrostis segtum)* is a very common pest in the experimental fields. To reduce its effects drenching is done soon after any planting. *Corchorus* seedlings also suffered severe attacks from damping off - *Rhizoctonia spp, Pythium spp.*

Yield

The poor emergence of the directly seeded *Corchorus* produced leaf yields that were significantly lower than that produced by the transplanted seedling: transplanted seedling produced ten times as much leaf (Table 7).

Table 7. *Cochorus olitorius*: Crop establishment trial - leaf yield data.

Plot No	Treatment	Total yield /plot (g)	Kg/ha
1	**Ds***	**224.1**	**250**b
4	**Ds**	**----**	**----**
5	**Ds**	**----**	**----**
7	**Ds**	**----**	**----**
10	**Ds**	**----**	----
2	**Ts**	**2394.6**	**2660**a
3	**Ts**	**2379.7**	**2644**a
6	**Ts**	**2002.3**	**2224**a
8	**Ts**	**2156.0**	**2396**a
9	**Ts**	**1639.3**	**1821**a
Mean		**2114**	**2348**

*Ds – Direct seeded plots
Ts – Transplanted plots

As a consequence of the improved plant development of the transplanted seedlings, seed yield was greatly increased (Table 8).

Table 8. *Cochorus olitorius*: Crop establishment trial - seed yield data.

Plot No	Treatment	Weight (g)	Weight Kg/ ha
1	Ds	72.1	80**b**
2	Ts	788.3	876**a**
3	Ts	749.1	832**a**
6	Ts	284.6	317**a**
8	Ts	796.3	884**a**
9	Ts	379.2	421**a**
Mean Ts		**599.5**	**661a**

*Ds – Direct seeded plots
Ts – Transplanted plots
a,b significant difference at $p < 0.05$ (Cv. 15.47%)

Cleome gynandra - Spider Plant Trial

The spider plant is a very popular summer vegetable in many African countries. It used to be gathered from the wild soon after the rains but to-date this trend has changed and in a number of areas it is found in the cultivated group of vegetables. There is a lot of variation in the plant morphology and taste and from the surveys conducted so far it was found out that some people prefer the bitter type while others go for the mild one hence research work should proceed with this in mind.

Objective
The various collections available at HRC have been going through evaluation and selection over the last few years. One landrace coded TZ/ZM received attention for its unique characteristics of high germination viability and its large leaf area.

Three trials were conducted with the following objectives:

Trial 1. Seed multiplication trial (Note: selfing to purify the variety has been going on in all the 3 trials).

Trial 2. Harvesting method trial where the two methods:

- complete harvesting where the whole plant stand is cut just above the second node and given a chance to rejuvenate;
- tip harvesting in which only the shoots are harvested.

Trial 3. Crop establishment method trial, where the two common methods of establishment viz direct seeding and transplants raised in seedling trays were assessed on general crop development and yield.

Trials 1 and 2

Methods and materials

Experimental design

Trials to meet the first two objectives were similar in design. Each trial had 10 plots of 13m x 3m. Rows were spaced at 0.5 m apart. Seed was mixed with some soil and drilled in the rows.

A basal fertilizer with an NPK ratio of 8 14 7 applied at 450 kg /ha. Top dressing fertilizer was applied at 100 kg / ha N.

Trial 1

The first trial was a seed multiplication trial and the leaf results were collected at thinning. (Table 8 and Table 9).

Table 9. Seed multiplication trial - leaf yield data.

Plot No	Block No	Wt (g)	Kg/ha
1	1	2636.3	675.90
2	1	1314.6	337.18
3	1	890.7	228.46
4	1	2891.2	741.28
5	1	3212.8	823.87
6	1	1764.2	452.31
7	1	377.0	96.67
8	1	264.9	67.95
9	1	2057.8	527.44
10	1	1508.4	386.67
Mean	1	**1691.8**	**433.8**

Table 10. Seed multiplication trial - seed yield data.

Plot No	Block No 1	Wt(g)	Kg/ha
1	1	303.1	77.69
2	1	754.4	193.33
3	1	755.2	193.59
4	1	279.5	71.80
5	1	266.3	68.21
6	1	264.5	67.95
7	1	280.8	71.05
8	1	228.5	58.72
9	1	428.6	110.0
10	1	289.3	74.10
Mean	1	**385.0**	**98.6**

Trial 2

Trial results show a higher leaf yield in complete harvesting plots and a correspondingly lower seed yield than tip harvesting (Table 11 and 12). This approach is more common with most farmers. The technique adopted in this trial

involved cutting the entire plant stem just above the second node from the ground. With this technique rejuvenation or rattoning after every harvest was observed to decline. This led to some plants not rattoning or becoming stunted.

Tip harvesting, a method also common with farmers, encourages development of a dense canopy after every harvest. It appears to be less damaging, as it does not predispose the plant to infection or insect attack: aphids are more harmful to rejuvenating plants than those tip harvested. The first harvest was 55 days from the date of sowing and continued for 26 days. The last harvest was completed after it was established that the bitterness and the lignin content had both gone up (in *Cleome* the two are maturity indices).

For complete harvesting to be a success one should administer a top dressing after every harvest.

Table 11: Leaf harvesting method: leaf yield

Plot No	**Treatment**	**Total yield (g)**	**Kg /ha**
1a	CH*	28908.7	7413
2a	CH	12009.2	3080
3a	CH	10039.8	2574
Mean		**16,985.7**	**4,356**
4b	TH	4453.8	1141
6b	TH	7721.1	1974
7b	TH	4586.2	1177
Mean		**5,587.0**	**1,431**

*CH: Complete harvested plots – Stem was cut at the second node from the ground level.
TH: Tip harvested plots.

Table 12: Leaf harvesting method: seed yield

Plot No	**Treatment**	**Kg/ha leaf**	**Kg/ha seed**
1a	CH	7413	24.62
2a	CH	3080	38.46
3a	CH	2574	34.87
Mean		**4356**	**326.5**
4b	TH	1141	37.44
6b	TH	1974	65.64
7b	TH	1177	46.15
Mean		**1097**	**47.74**

*CH: Complete harvested plots – Stem was cut at the second node from the ground level.
TH: Tip harvested plots.

Trial 3

Cleome has a slow growth during the first three weeks after germination. Growth is further reduced when weed competition is high, hence the need to develop an

alternative establishment method using transplanted seedlings. The methods of transplanting and direct seeding were compared in relation to leaf and seed yield. This trial should eventually provide proper recommendations for the commercial production of *Cleome gynandra.*

Materials and method

Experimental design

A randomised complete block design with two treatments of direct seeded and transplanted were established on five replicate plots measuring 3 x 3m.

A basal fertilizer with an NPK ratio of 8 14 7 was applied at 450 kg /ha. Top dressing fertilizer (ammonium nitrate 34.5% N) was applied at 100 kg / ha N.

Results

Generally there is delayed harvesting in direct seeded plants due to their initial slow development. Transplants develop much faster to attain a large frame of harvestable leaf. This is an important characteristic in *Cleome.*

Visual observations suggested that the transplants were more dense than direct sown plants. Direct sown plots flowered after 34 days from the day of sowing while it was 27 days for those raised in seedling trays. This means a prolonged harvest with direct seeded plants.

The transplanted seedlings produced higher total yields of leaf compared to the directly sown plants (Table 13). However, there were no significant differences in seed yield (Table 14).

Table 13. *Cleome*: direct seeded plots vs. transplanted plots - leaf yield.

Plot No	**Treatment**	**Total yield/plot (g)**	**Kg /ha**
1	Ds*	1381.9	1533
4	Ds	1593.9	1767
5	Ds	781.3	867
7	Ds	304.1	333
10	Ds	345.2	383
Mean		**881.7**	**977**
2	Ts	2474.1	2744
3	Ts	3755.9	4178
6	Ts	1676.6	1867
8	Ts	1315.8	1467
9	Ts	1063.9	1178
Mean		**2,057.3**	**2,289**

*****Ds – direct sowing
Ts – transplanted seedling

Table 14. *Cleome*: direct seeded plots vs. transplanted plots – seed yield.

Plot No	**Treatment**	**Wt(g)**	**Kg/ha**
1	Ds*	91.9	102.2
4	Ds	115.0	127.8
5	Ds	158.7	176.7
7	Ds	153.6	171.1
10	Ds	66.5	73.3
Mean		**117.1**	**130.2**
2	Ts	47.3	52.22
3	Ts	190.2	211.11
6	Ts	117.7	131.11
8	Ts	194.6	266.67
9	Ts	86.3	95.56
Mean		**127.2**	**151.3**

*****Ds – direct sowing
Ts – transplanted seedling

Lagenaria siceraria - Vegetable Bottle Gourd Trial

Current Production and Marketing of Vegetable Bottle Gourd in Matabeleland South Province of Zimbabwe

Information on current production practices and the planting material diversity of the edible bottle gourd, *Lagenaria siceraria* was collected from the Matebeleland South province. This area was selected for germplasm collection because it lies in the centre of diversity of the gourd and is extensively used in this area of Zimbabwe. A total of 11 group interviews (of up to five people in each) were conducted.

Semi-structured interviews were carried out to ascertain the range of varieties, preference and time of planting, maturity indices, harvesting and post-harvest handling of the bottle gourd fruits. Aspects relating to agronomic practices such as varietal selection, planting and seed processing and storage were also investigated as were the socio-economic factors as to who is responsible for seed selection, taking care of the crop in the field, harvesting and the preparation of the fruits for use as food. Results from these interviews were collated to form part of the useful critical known but undocumented information on this crop.

Prolonging shelf life

The effect of three harvest maturity intervals, 10 days after fruit set (DAFS), 15 DAFS and 20 DAFS, and three levels of a sucrose polyester coating called Semperfresh™, (0.4%, 0.8% and 1.2% dilution) on the shelf life of three bottle gourd varieties stored under ambient conditions was studied.

The three varieties used were the most preferred varieties in the communities where the seed had been collected. They were subjected to three harvesting intervals of 10, 15 and 20 days after fruit set and stored under ambient room conditions over a period of 14 days.

At the respective harvesting intervals, all the fruits were weighed separately and weight data recorded. At intervals over the storage period, the fruit were reweighed.

After the weights for the fruits had been recorded, each of the fruits scheduled for assessment on the first day (day 0) i.e. fruit number 1 was assessed for freshness using the following scale:

1 Fresh, smooth, glossy skin without wrinkles, white hairs on fruit skin.
2 Dull colour, no gloss but white hairs still present on the skin
3 Dull colour, no gloss and white hairs falling off.
4 Very dull colour, most hairs fallen off the skin, fruit slightly wrinkled starting from the stem end and dark spots from bruises visible.
5 Fruit extremely wrinkled, dark spots from bruises very prominent.

Fruit firmness was assessed by piercing the fruit skin with the fingernail and subjectively assessing the firmness (1- very hard skin to 5 - very soft skin)

Internal colour was assessed using the following scale:

1 White or yellowish succulent pulp.
2 Dull white or yellow but pulp still succulent.
3 Dull white or yellow medium succulent pulp.
4 Off-white/brownish pulp, seed separating from pulp and pulp drying starting from the blossom end.
5 Off-white/brown, not succulent, most seed separated from the pulp and advanced drying from blossom end scar.

In order to determine whether there was an accumulation of fermentation products in storage, each fruit was individually assessed for the presence of off-smells. A scale of 1 to 3 based on the following observations was used:

1 No odour detected.
2 Odour detected but not strong.
3 Strong odour detected.

Total soluble solids were measured on a sample of the fruit obtained from the equatorial section of the fruit that contained part of the seed cavity (but not the seed) and the flesh (but not the rind) was crushed using a garlic press and the juice placed on the prism of an ATAGO N1 refractometer (Brix: 0-32%, Tokyo, JAPAN). The same measurements were taken every other day until day 14.

In addition, fruits harvested 10 days after fruit set (DAFS) were further subjected to assessments for eating quality. Fruits were assessed one day after harvest because producers reported taking their produce to the market a day after harvest while the six-day period was chosen because maximum shelf life had been reported to be between five and seven days after harvest.

Weight data (% weight loss) was first transformed using the *square root* transformation before analysis because weight loss was concentrated in lower quarter of the scale i.e. between 1 and 19%. Where scores/ranks were used, data was transformed using the *log(x+1)* transformation before the analysis except on the sensory evaluations where simple averages were computed. The log(*x+1*) transformation was used instead of the simple log(x) to accommodate scores of 1, which would have given 0 (zero) scores after transformation. Total soluble solids data was not transformed. An analysis of variance (ANOVA) was carried out on all the data collected using the GENSTAT 5 Release 3.22 Statistical Package. Results are presented for data collected up to 10 days in storage because beyond 8 days storage, most fruits were no longer suitable for consumption as a result of loss of flavour and/or skin hardening.

Effect Of The Edible Fruit Coating Semperfresh™ On The Shelf Life Of Three Bottle Gourd Varieties Stored Under Ambient Conditions

In the second experiment, 120 fruits from each of the same 3 varieties as described in the previous experiment were harvested 10 days after fruit set (DAFS) and subjected to five different fruit coating treatments:

1 Standard practice – gourds not exposed to any treatment before storage.
2 Control – fruits dipped in tap water and allowed to drip-dry.
3 Dipping fruits in a 0.8% Semperfresh™ solution in a swift dip-and-remove motion.
4 Dipping fruits in a 0.4% Semperfresh™ solution in a swift dip-and-remove motion.
5 Dipping fruits in a 1.2% Semperfresh™ solution in a swift dip-and-remove motion.

Semperfresh™ consists of sucrose esters of fatty acids - E473, sodium carboxymethylcellulose - E466 and mono/diglycerides of fatty acids - E471.

The measurements taken were similar to those in experiment 1: percent weight loss over time, external and internal freshness, firmness and total soluble solids (TSS) and were similarly analysed.

To determine whether Semperfresh™ had any effect on the eating quality of the vegetable bottle gourd, Semperfresh™-treated and -untreated fruits were subjected to palatability assessments. The fruits were assessed for taste, freshness, skin texture and pulp texture. As in experiment 1, a taste panel consisting of four assessors was used to evaluate the suitability of the fruit for consumption. Each assessor was used as a replicate. Forty uniformly-sized and ripened fruit of the same variety were divided into five groups of eight fruits each and a group was randomly allocated to any one of the following treatments:

1 0.8% Semperfresh™ coating
2 4% Semperfresh™ coating
3 1.2% Semperfresh™ coating
4 Control (standard), no coating and no washing
5 Cold storage at 4^0C

The cold store treatment was included purely for observational purposes and it was not part of the main fruit coating treatments.

At 2, 4, 6 and 8 days storage after harvest, two fruits from each treatment were prepared by boiling them in water. No additional condiments were added to avoid adulterating the natural taste of the gourds As in experiment 1, assessors were encouraged to thoroughly rinse their mouths before moving to the next treatment. Assessors used the scale below:

Taste	1 - ideal taste
	2 - acceptable taste
	3 - off-taste
Freshness	1 - fresh
	2 - acceptable
	3 - no longer acceptable
Skin texture	1 - ideal
	2 - firm but still acceptable
	3 - hard
Pulp texture	1 - fine texture, ideal
	2 - acceptable but getting gritty
	3 - unacceptable

Average scores were computed and means compared to determine the acceptability of the fruits following the different treatments.

As in the first experiment and for the same reasons, results are presented for data collected up to 10 days in storage.

Results

Current Production, Harvesting And Post-harvest Handling Practices

Varieties cultivated and uses

Cultivation of mixtures rather than pure varieties was preferred as a strategic way of cushioning the growers against crop failures in the event of adverse conditions. Varieties were distinguished from each other using external morphological features such as fruit shape, presence or absence of warts on the fruit surface, fruit size and fruit colour. However, no specific names were given to the different varieties that were cultivated. Internal features such as pulp colour and succulence were also used. Yellow-fleshed varieties were preferred to the white-fleshed varieties and 'sweet' tasting rather than bland or flat varieties.

All the people interviewed reported cultivating bottle gourd for use as a vegetable and stressed its importance in periods of food scarcity where it provided the communities with an alternative and early food source before the main cereal crop. They cultivated bottle gourd during the wet season (summer) as an intercrop. The gourds were planted at the same time as an intercrop with the main cereal crop at the onset of the rains. The gourds could be harvested during any time of the day for home consumption while those intended for marketing were usually harvested late during the day or early in the morning on the market day.

Judging the maturity of the fruit is important for post-harvest quality. Maturity indices that are used are described in table 15 below.

It was noted that for home consumption, these indices could be easily overlooked depending on the abundance or scarcity of food at any particular time of the year. When there is food scarcity, the fruit could be harvested at a very tender age, say 14 days from fruit set.

Table 15. Traditionally used maturity indices for bottle gourd

Attribute	**Description**
Size	Expected size for most varieties known from long experience of cultivation.
Feel	Skin easily punctured with the fingernail, over-mature fruit has a hard rind.
Skin appearance	Skin shiny at horticultural maturity, tiny white hairs that are very pronounced in the early premature phases start to drop off from the fruit starting from the blossom-end to the stem-end, skin colour turns light green; fruits that have warts

	on their skin have fewer hairs, therefore this index is less useful in these varieties
Age	Harvesting expected in 2-3 months from sowing, fruit may also be harvested from 2-4 weeks from fruit set depending on intended use.
Seed texture	Over-mature fruit has hard seed inside the fruit that does not cook.

The preparation method used to cook gourds depended on the stage at which the fruit was harvested. Unless there were severe food shortages, the fruit was traditionally harvested using the indices outlined in table 2 above.

Effect Of Harvest Maturity On The Shelf Life Of Three Bottle Gourd Varieties Stored Under Ambient Conditions

Weight Loss

The three varieties showed significant differences in the rate at which their fruits lost weight over the two-week storage period (P = 0.01).

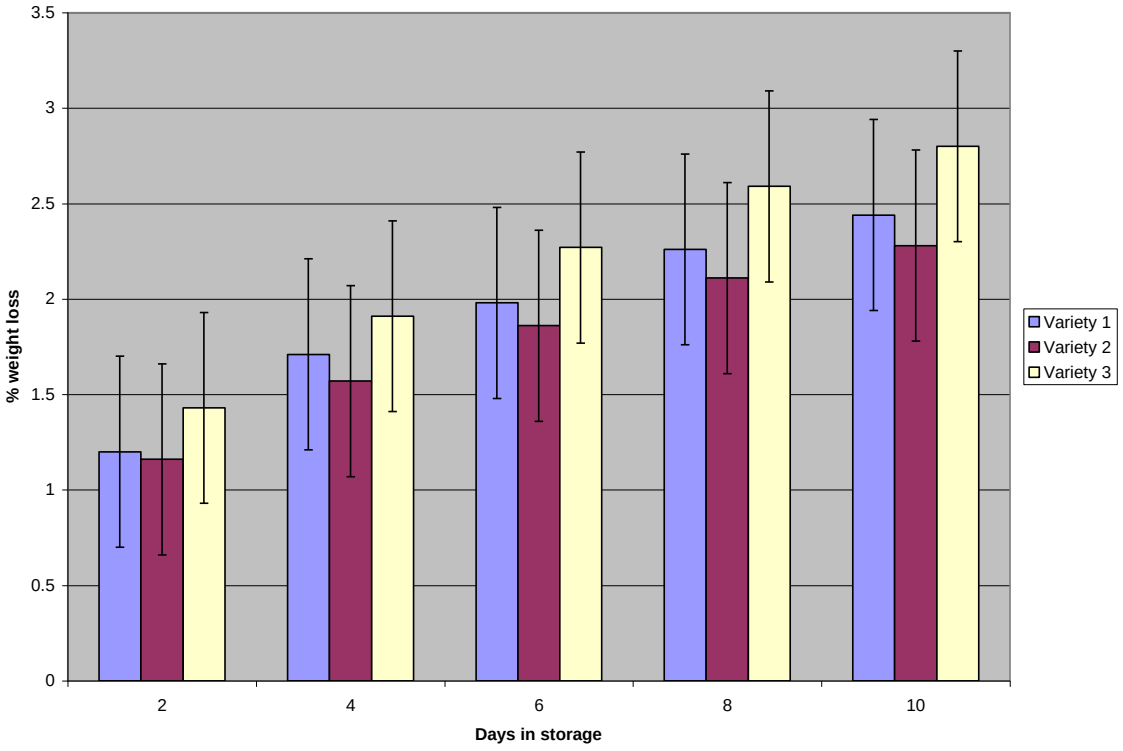


Figure 1. Effect of variety on weight loss (%) in fruits of vegetable bottle gourd stored for 10 days under ambient conditions *(data transformed using the square root transformation).*

Variety 3 consistently lost more weight whenever the measurements were taken and had lost the greatest weight at the end of the experiment. Over the entire storage period, variety 2 consistently lost weight at the lowest rate in comparison with the other two varieties. No significant differences in mean weight loss were observed among the three harvest intervals at the 5% level. There was also no significant interaction between harvest interval and variety at the 5% level of significance.

External Appearance

Freshness scores showed that fruit harvested 20 days after fruit set (DAFS) lost freshness at a slower rate than those that had been harvested at 10 and 15 DAFS (Figure 2). At the beginning of the experiment, the 10- and 15-day harvest intervals were equally fresh, but from two days storage onwards, significant differences (P = 0.01) became evident across all the three harvest intervals. Loss of freshness in fruits harvested 20 DAFS was more gradual (up to 6 days) compared to fruits in the other 2 treatments. Unlike fruits harvested in the other 2 intervals, fruits harvested 20 DAFS were still fresh after 6 days in storage after which loss in freshness became so rapid such that by 8 days in storage, the fruits had deteriorated to the same level as those harvested at the 15-day harvest interval. .

No significant differences in external freshness appearance among the three varieties (P = 0.05) were observed.

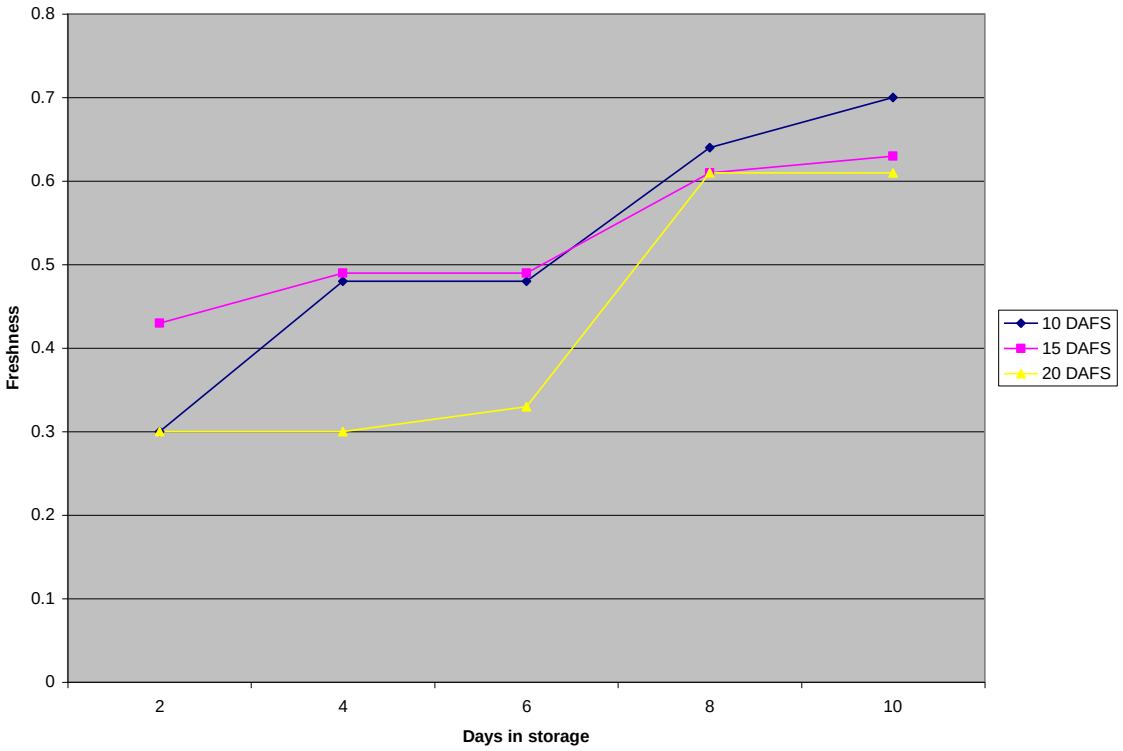


Figure 2. Effect of harvest maturity on loss of freshness in fruits of vegetable bottle gourd stored for 10 days under ambient conditions *(data transformed using the square root transformation).*

Fruit Firmness

Significant differences in fruit firmness were observed among the 3 harvest maturity intervals (P = 0.01) as shown in table 16 below. Fruits harvested at the 10 DAFS were the softest at the start of the experiment and remained so up to 6 days in storage when the pattern became distorted. On the other hand, fruits harvested at the more advanced 20 DAFS age were the hardest at the start of the experiment and after 2 and 10 days in storage. At the 4-, 6- and 8-day storage intervals, this trend was not so

evident. No significant differences in fruit firmness were observed among the 3 varieties (P = 0.05).

Table 16. Effect of harvest interval on firmness of vegetable bottle gourd fruits stored for 10 days under ambient conditions

Harvest maturity (days after fruit set)	**Storage duration (days)**					
	0	**2**	**4**	**6**	**8**	**10**
10	0.78	0.78	0.65	0.60	0.40	0.46
15	0.75	0.73	0.63	0.63	0.57	0.34
20	0.68	0.69	0.66	0.66	0.44	0.33
SED	**0.02**	**0.02**		**0.02**	**0.05**	**0.05**
Significance	**	**	**ns**	**	**	**

** Significant to 1% level

Internal Fruit Succulence

The harvest interval significantly affected retention of succulence in the fruit at the 4- and 6- day storage intervals only (Table 17). At these storage intervals, fruits harvested at the 20 DAFS interval were more succulent and therefore lost significantly less moisture than those harvested at the 10 and 15 DAFS intervals. However, no significant differences in loss of succulence (P = 0.05) were observed among the three bottle gourd.

Table 17. Effect of harvest interval on loss of succulence in vegetable bottle gourd fruits stored for 10 days under ambient conditions (** Significant to 1% level)

Harvest maturity (days after fruit set)	**Storage duration (days)**					
	0	**2**	**4**	**6**	**8**	**10**
10	0.30	0.30	0.39	0.46	0.59	0.63
15	0.30	0.32	0.48	0.60	0.61	0.65
20	0.30	0.32	0.32	0.32	0.58	0.62
SED			**0.02**	**0.02**		
Significance	**ns**	**ns**	**	**	**ns**	**ns**

Development of Off-Flavours

When the fruits were assessed for off-flavours over the storage period, no off-flavours could be detected at all

Total Soluble Solids

Total soluble solids content (TSS) varied significantly among the varieties (P = 0.01) over the duration of the experiment (Figure 3). The highest TSS (5.12% Brix) was recorded in variety 2 after four days in storage. Variety 1 had the lowest %Brix for the entire duration of the experiment. In all the three varieties, TSS content increased after harvest, attaining a maximum after four days in storage. Thereafter, TSS started to fall but did not get below the initial TSS content until after eight days in storage for varieties 1 and 2 and after 10 days for variety 3. Variety 3 retained its 'sweetness' over a longer duration than the other three varieties.

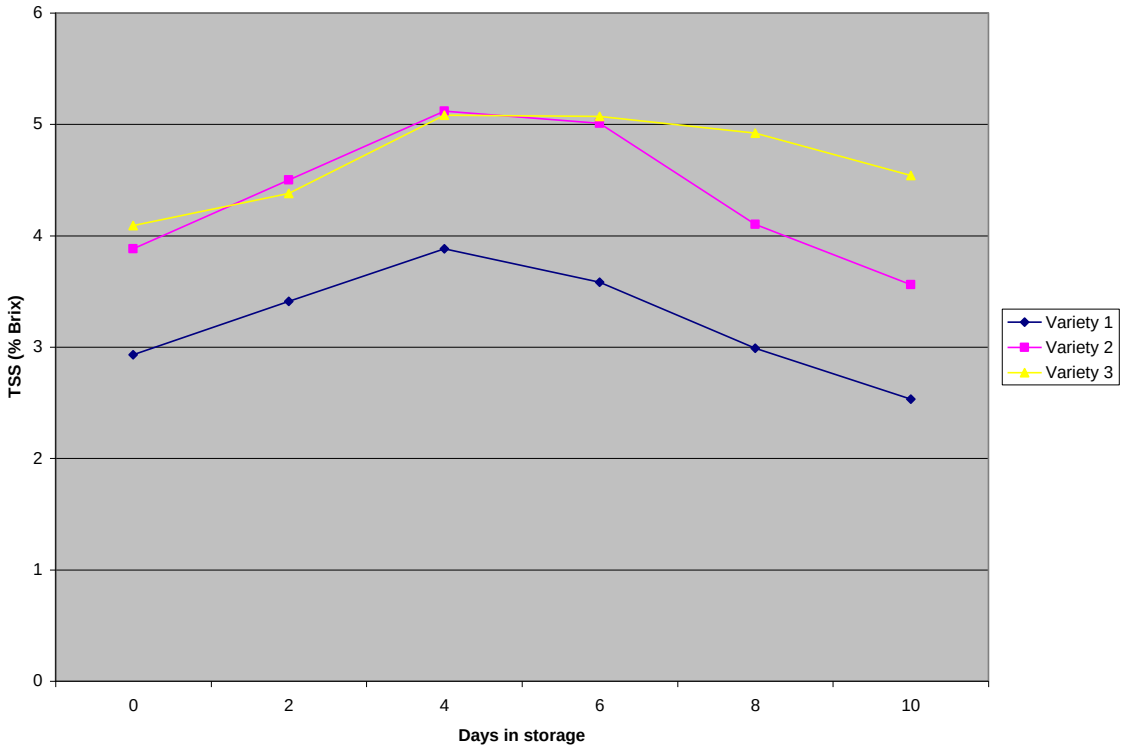


Figure 3. Effect of variety on total soluble solids content (% Brix) in fruits of vegetable bottle gourd stored for 10 days under ambient conditions *(data transformed using the square root transformation).*

Significant differences were observed among the three harvest intervals (P = 0.01 and P = 0.02 at the 4 day storage period) except at the 10 day storage interval when no significant differences were observed. Figure 4 illustrates the effect of harvest interval on the TSS content of bottle gourd fruits.

In all the three harvest intervals, TSS gradually increased until 4, 6 and 8 days storage for the 10-, 20- and 15 DAFS intervals respectively. The highest TSS of 5.73 % Brix was recorded in the 20 DAFS interval after the fruits had been kept in store for 6 days.

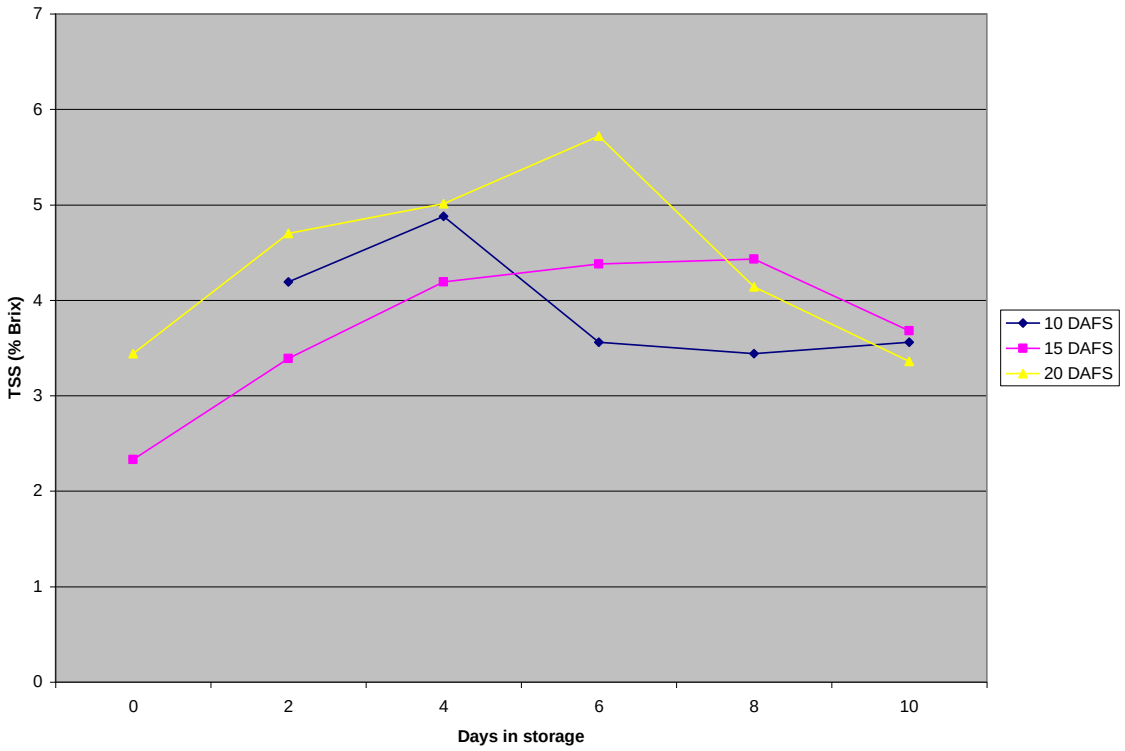


Figure 4. Effect of harvest interval on total soluble solids content (% Brix) of vegetable bottle gourd stored for 10 days under ambient conditions *(data transformed using the square root transformation).*

Assessment of Eating Quality

The average scores for eating quality are shown in table 18 below. One day after storage, variety 3 was ranked the freshest, followed by variety 2. After six days, variety 3 still exhibited an acceptable level of freshness, while variety 2 was no longer fresh although still acceptable. Over the storage period, variety 3 consistently received a better score for freshness than the average for the three varieties.

Variety 3 had the finest texture of all the three varieties after one day in storage. After six days in storage, the same variety was still acceptable with an intermediate texture, while varieties 1 and 2 had developed a gritty texture.

Table 18.. Assessment of vegetable bottle gourd fruits for eating quality (mean scores)

Days in Storage	Variety	Freshness	Texture	Sweetness
1	1	1.75	1.75	2.25
	2	1.25	1.25	1.75
	3	1.00	1.00	1.00
	Mean	**1.33**	**1.33**	**1.67**
6	1	2.50	3.00	2.75
	2	3.00	3.00	1.75
	3	2.25	2.25	1.50
	Mean	**2.58**	**2.74**	**2.00**

Effect Of The Edible Fruit Coating Semperfresh™ On The Shelf Life Of Three Bottle Gourd Varieties Stored Under Ambient Conditions

Weight Loss

Semperfresh™ was effective in reducing the rate of weight loss in bottle gourd fruits. Non-treated fruits lost more weight than treated fruits (Figure 5). No significant Semperfresh™ by variety interaction effects on weight loss were observed (P = 0.05).

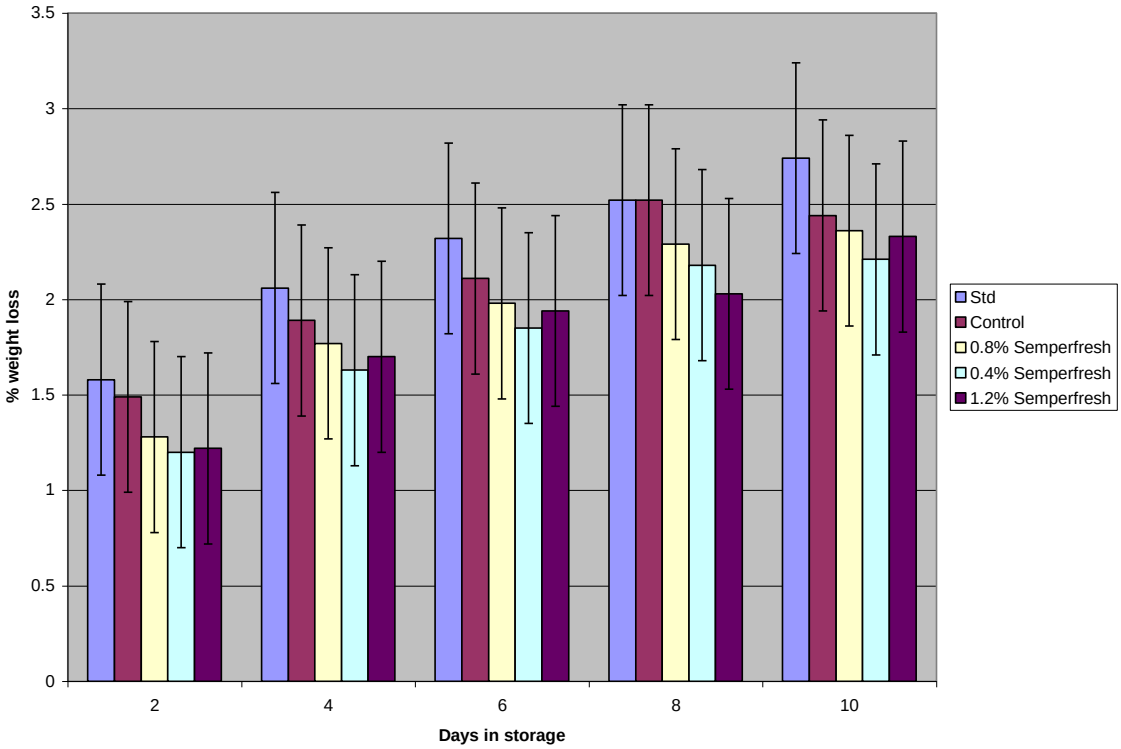


Figure 5. Effect of Semperfresh™ fruit coating on weight loss (%) in fruits of vegetable bottle gourd stored for 10 days under ambient conditions *(data transformed using the square root transformation).*

Variety effects on water loss were highly significant (P =0.01). The same pattern as had been observed in experiment 1 was observed where variety 3 consistently lost more weight over the storage period than the other two varieties was also observed after the Semperfresh™ treatment.

External Appearance

Coating bottle gourd fruits with Semperfresh ™ did not give any positive benefits in retaining the desired external appearance of the fruit. Significant differences between treated and untreated fruits were observed at the 2-, 8- and 10-day storage intervals but in this case the standard and the control treatments were either superior or similar to the treatments (results not presented).

No significant differences in freshness retention were observed among the three varieties after Semperfresh ™ treatment except at the two-day storage interval when

variety 2 appeared to have lost its freshness more than the other two varieties (Figure 6).

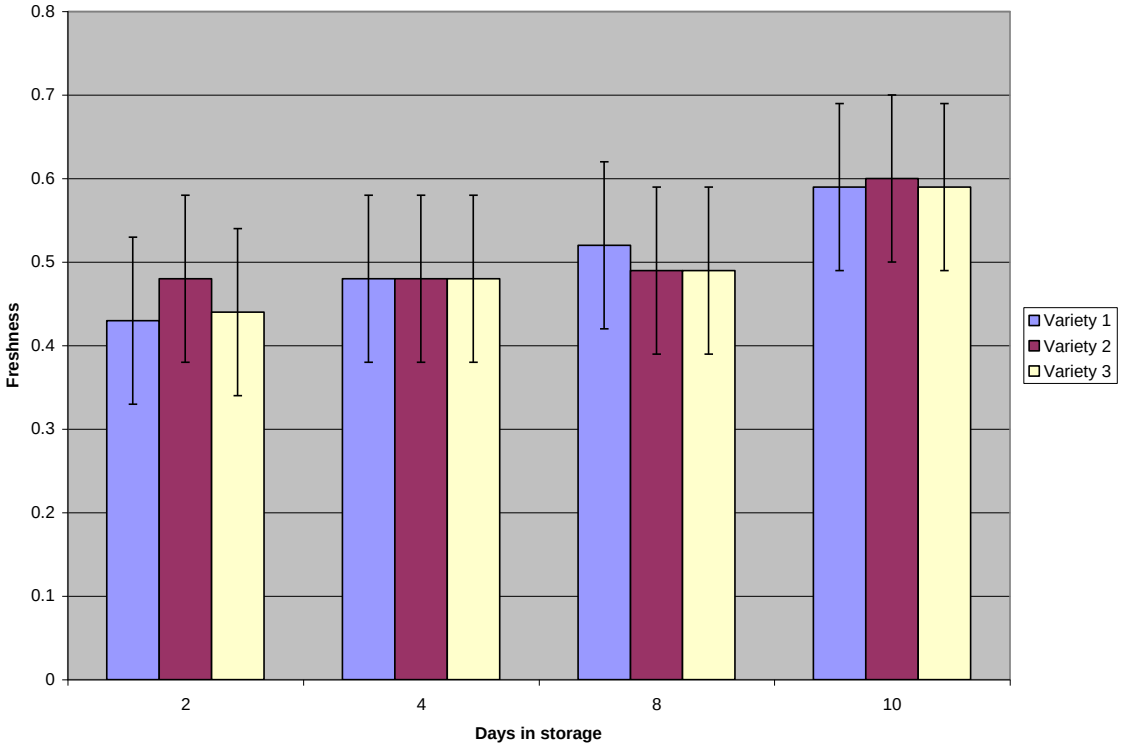


Figure 6. Effect of variety on loss of freshness in fruits of vegetable bottle gourd treated with Semperfresh™ and stored for 10 days under ambient conditions *(data transformed using the square root transformation)*

Fruit Firmness

No significant differences in fruit firmness among the 3 varieties were observed throughout the storage period (P = 0.05), indicating that fruit harvested at the same firmness hardens at the same rate regardless of variety. At the same time, no significant interaction between variety and Semperfresh™ treatment were observed (P = 0.05). However, effects of Semperfresh™ treatment were observed at the 2-, (p = 0.05), 4-, 6- and 8- (p = 0.01) day storage intervals. Figure 7 below illustrates the decrease in softness i.e. increase in hardening in fruits treated with the different Semperfresh™ treatment.

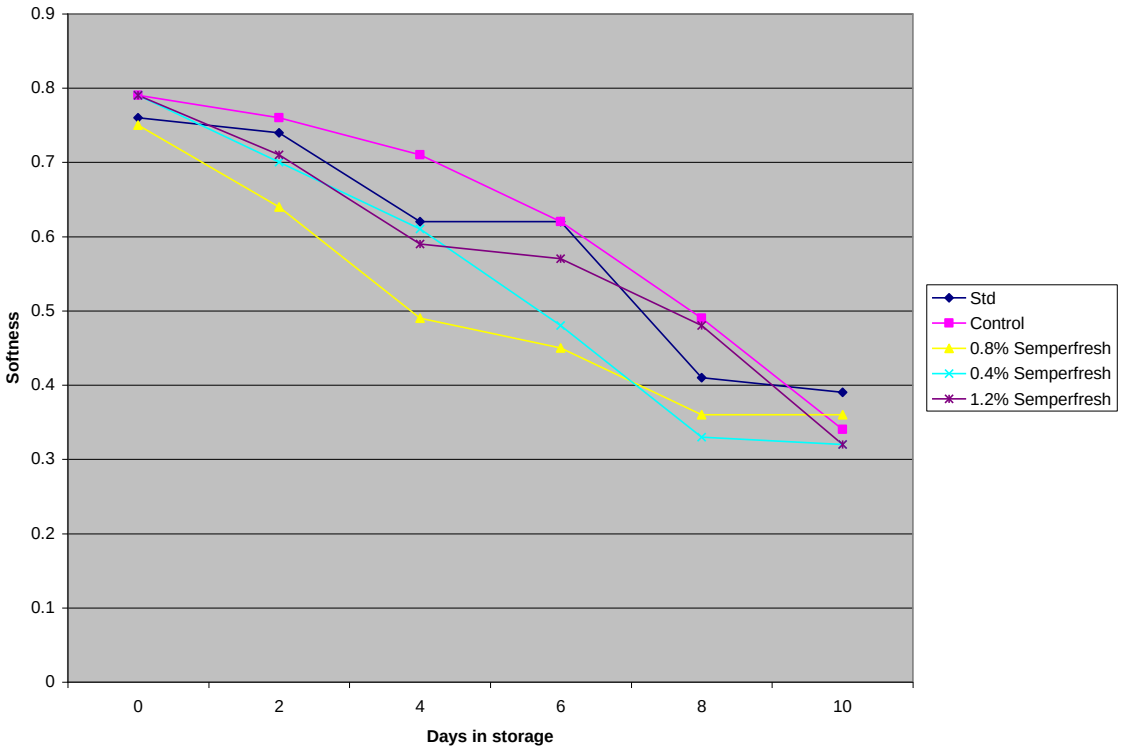


Figure 7. Decrease in softness in Semperfresh™ treated vegetable bottle gourd fruits stored for 10 days under ambient conditions *(data transformed using the square root transformation)*

Internal Fruit Succulence

No significant differences in succulence were observed among the three varieties during the 10 day observation period while the benefits of coating the fruits with Semperfresh™ were only observed at the six-day storage interval when the treated fruits were able to retain their succulence better than the untreated fruits.

Development of Off-Flavours

As in the previous experiment, no off-flavours were detected in all the treatments for the duration of the experiment and the same reasons as previously presented would equally apply.

Total Soluble Solids

As in experiment 1, inherent differences among varieties resulted in significant differences in the TSS content of the three varieties. Similarly as in experiment 1, variety 3 always had higher TSS content than the other two varieties whenever the measurements were taken during the storage period.

Assessment Of Semperfresh™ Coated Fruits For Eating Quality

The average scores for eating quality after treatment with Semperfresh™ followed by storage at ambient and in a cold store (temperature 4^0C) are shown in table 19 below.

Though inconsistent, fruits kept in the cold store received the best scores for all the attributes measured for the whole duration of the experiment. After 8 days in storage, fruits kept in the cold store were still acceptably tastier, fresher and managed to retain both their skin and pulp texture at ideal and accepted levels. Of the 3 Semperfresh™ coating treatments, the 0.8% and the 0.4% Semperfresh™ coating treatments managed to retain the taste of the fruits better than the 1.2% treatments and the control.

Table 19. Assessment of bottle gourd fruits for eating quality after treatment with Semperfresh™ (mean scores)

Quality attribute	**Taste**			**Freshness**			**Texture**			**Pulp texture**		
Storage (days)	2	6	8	2	6	8	2	6	8	2	6	8
0.8%SPE*	1.75	2.00	2.25	2.00	2.00	2.25	2.25	2.66	2.75	2.00	2.16	2.50
0.4%SPE	1.25	2.00	2.50	1.75	2.00	2.63	2.00	2.00	2.75	1.25	2.00	3.00
1.2%SPE	1.00	2.33	2.50	1.00	2.00	2.38	1.75	2.66	2.50	1.25	2.33	3.00
Control	1.00	2.33	2.25	1.25	2.66	2.38	1.50	2.66	2.50	1.00	2.67	3.00
Cold store	1.50	1.66	1.38	1.75	1.33	1.38	1.50	1.33	1.25	1.50	1.33	1.00
Mean	**1.30**	**2.06**	**2.18**	**1.55**	**2.00**	**2.00**	**1.86**	**2.26**	**2.35**	**1.40**	**2.10**	**2.50**

Fruits treated with Semperfresh™ tasted fresher than the control up to six days in storage. However, Semperfresh™ increased the firmness of the fruits as evidenced by the higher scores in skin texture in comparison with the control and the cold-store kept fruits. The Semperfresh™ treatment helped to retain the pulp texture better than the control up to 6 days as seen in the low scores allocated to these treatments in comparison with the control.

Summary conclusions

In summary, results indicated that the variety played a significant role ($p = 0.05$) in the rate of water loss from the fruit and the total soluble solids content (TSS) in the fruit, but did not play a major role in determining the rate of loss of visual appeal and in the hardening of the fruit skin in storage. The results also indicated that the harvest interval was very important in determining the visual appeal of the fruit in storage, the subsequent progression of fruit skin hardening and the TSS content of the fruits ($p = 0.05$). Fruits harvested 20 DAFS maintained their visual appeal better, accumulated the highest TSS but had the hardest fruit skins while those harvested 10 DAFS had the poorest appearance and had the lowest TSS as storage was prolonged but their skin softness remained superior to the other two harvest intervals. Across the three varieties and the three harvest intervals, TSS initially rose, attaining a maximum after 4 - 6 days in storage before falling down. Variety 3 was superior in taste and had the

highest TSS content. Coating the fruit with the sucrose polyester (SPE) Semperfresh™ significantly reduced the rate of weight loss from the fruits and delayed peak TSS attainment in the fruit ($p = 0.05$), however coated fruits lost their visual appeal and developed a hard skin. Since fruit skin hardness is the single most important determinant of fruit acceptability for consumption and since fruit is sold on a volume and not on a weight basis, it is concluded that the optimum harvest interval for any variety of choice is 15 DAFS and that the external appeal of the fruit alone is not a good indicator of the acceptability and suitability of the fruit for consumption. Coating the fruits with Semperfresh™ is not recommended for fruits intended for the fresh market because its benefits are out-weighed by its disadvantages.

Cowpea (*Vigna unguiculata* (L.) Walp) Trial

Cowpea is widely grown in Africa for its tender leaf, tender pod and dry grain and is among the top four leaf vegetables in eastern and southern Africa. In Zimbabwe, both the leaf and the grain are consumed. There are conflicting reports on whether leaf picking reduces grain yield or not. These conflicting observations could be due to varietal differences and the period the crop is exposed to leaf picking. Traditionally leaf picking starts as early as from four weeks through to the reproductive stage. The varieties commonly available are the photosensitive landraces that inherently produce large amounts of leaf and less grain. The leaf is picked on availability and on demand and as result the crop is always given a chance to re-grow before the next leaf harvest. Such picking might not have adverse effects on grain yield. The recently bred varieties being recombinants of landraces and grain type varieties have the potential of producing leaf and grain yields that are comparable to both parents. These varieties need to be evaluated for their leaf yield as well as grain under the condition where leaf picking depends on availability.

It is possible that varietal differences in respect to nutritional composition may exist and also different processing methods may have an impact. There is need to evaluate different cowpea genotypes for their nutritional composition and also to assess the nutritional composition of the leaf products prepared by using three common traditional methods. It is also important to compare the nutritional composition of the multi-line landraces with pure breeding lines. Such knowledge will help in giving proper recommendations on suitable varieties and on composition of diets, where cowpea plays an alternative role to animal protein and also to enable to recommend traditional leaf preparation methods that result in less loss of nutritive value.

A programme of research to evaluate the effect of leaf picking on grain yield of different cowpea genotypes was undertaken by Rosalia Madamba of the Department of Research and Specialist Services. Crop Breeding Institute Research. The project supported this research programme:

i) to evaluate the nutritional composition of different cowpea genotypes and the effects of processing methods on the nutritional composition of the dried leaf;
ii) to assess the economic returns from dual purpose varieties to determine the optimum harvesting strategy;
iii) to produce seed and dissemination material (Output 4).

Evaluating the nutritional composition of different cowpea varieties

Materials and methods

Fourteen sun-dried cowpea leaf samples from different varieties and two traditionally prepared leaf samples were chemically analyzed for their water, carbohydrates, fat, protein, ash and fibre contents by the Chemistry and Soils Research Institute. The fourteen samples consisted of cowpea leaves picked at Harare Research Station from one released variety CBC 1, two pre-releases, CE475/89 and CE82-16, two landraces, ZINYEMBA and LANDRACE and the remainder being other promising varieties.

The two samples of traditionally prepared dried leaf originated from the Harare urban market and a smallholder farmer in the Chiota communal area. The protein content was determined using Kjeldahl method and the carbohydrate content by difference.

The Department of Biochemistry, University of Zimbabwe analyzed seven leaf samples including; fresh cowpea leaf, uncooked dried cowpea leaf and cooked dried cowpea leaf from research station, cooked and dried leaf from the smallholder farms, *Cleome*, pumpkin leaf and covo leaf (*Brassica* spp) for their vitamin A activity using the Carr-Price method. Three replications per sample were analyzed.

Results

The uncooked dried cowpea leaves of the different varieties ranged between 0.94-1.91 % fat, 6.93-8.41% ash, 40.29-43.30% protein, 8.22-10.22% fiber and 27.27-33.26% carbohydrate (Table 19). The range of the nutritional composition of the leaf from different varieties observed in this study are similar to those reported in other studies. The narrow range in the leaf protein observed in different cowpea varieties, including those originating from the International Institute of Tropical Agriculture and the recombinants, suggests this aspect is not a trait that has to be measured in varietal assessment.

When compared to the uncooked dried leaves, the protein content for the cooked dried leaves from the urban market with 33.97% and smallholder farm with 35.97% were lower. However, their carbohydrate content was higher (Table 20). The fiber, ash and fat contents of the cooked dried leaf were within the range of the uncooked dried leaf.

The contents of the vitamin A activity differed significantly ($p > 0.001$) among the leaf vegetable types and preparations (Table 21).

Table 19. Percentage nutritional composition of dried leaves of cowpea varieties

Variety	Water	Fat	Ash	Protein	Fibre	CHO
C/7/5/5	9.88	1.34	8.06	43.04	8.91	28.77
C/5/5/18	9.86	1.58	7.86	41.17	9.22	31.31
C/4/5/10	9.72	0.98	8.26	40.72	9.51	30.81
CE82-16	9.40	1.72	8.41	43.04	9.96	27.57
ZINYEMBA	9.18	1.69	7.76	42.63	9.17	29.57
CE475/89	9.23	1.87	8.29	40.29	9.35	30.97
C/7/5/23	8.81	1.15	7.79	43.30	9.19	28.76
C/7/5/29	9.90	0.94	7.79	42.67	9.73	28.97
C/33/5/7	8.73	1.66	7.86	42.24	8.75	30.76
C/26/5/26	9.65	0.94	7.41	42.01	8.89	31.10
C/18/5/18/1	10.95	1.91	8.18	41.58	10.11	27.27
CBC 1	9.03	1.77	7.26	40.72	10.22	31.00

C/31/5/17	9.62	1.65	6.93	42.44	9.26	31.10
LANDRACE	8.39	0.96	7.92	41.13	8.34	33.26

Table 20. Percentage nutritional composition of cowpea leaf from different preparations

Leaf product	Water	Fat	Protein	CHO	Fibre
Uncooked fresh leaf	88	0.3	5	4	1.8
Uncooked dried leaf	9.18	1.69	42.63	29.57	9.17
Cooked dried leaf-Chiota	10.46	1.51	35.97	34.19	8.01
Cooked dried leaf –urban market	8.70	2.84	33.97	38.40	8.71

Table 21. Vitamin A activity of different local vegetables (IU/g)

	Fresh	Cooked dried	Uncooked dried
Covo	77.67	101.33	-
Pumpkin	86.33	119.00	131.33
Cowpea leaf Chiota communal area	-	124.67	-
Cowpea leaf urban market	-	116.00	-
Cowpea leaf, CBC1 variety	67.67	112.33	119.00
Mean = 105.53, Se$\pm$ = 0.907 (df/20), P < 0.001, LSD = 1.9			

Economic returns from dual purpose varieties

Background

As highlighted above, the landraces of cowpeas in Zimbabwe are cultivated for both leaf and bean. The leaf is usually dried by the farmer who then sells the dried product, either directly to consumers or to wholesaler/traders. A programme of research to evaluate the effect of leaf picking on grain yield of different cowpea genotypes has been undertaken by Rosalia Madamba of the Department of Research and Specialist Services, Crop Breeding Institute Research. Grain yield response to leaf picking differed among varieties (Madamba, personal comm.). Leaf picking significantly ($P<0.05$) reduced grain yield in some new varieties. The grain yield of local landraces increased, although not significant, with leaf picking. Three cowpea varieties; CE475/89, C/2/5/10, and C/7/5/5 were found to be the best varieties, considering their grain yield, leaf yield, seed sizes and seed colour in relationship to the commercial variety CBC1 and other varieties. However, it was considered important to assess the impact of leaf harvesting on the economic returns from these

varieties.

Method

Price data on dried cowpea leaf and beans were collected from Mbare market, Harare from November 2002 to January 2003. Both dried leaves and beans are sold by volume in various containers e.g. cups, tins of varying sizes. Some dried leaves and beans were purchased to determine the weight sold in the various containers in order to calculate the value of the harvests from the varietal trails.

Yield data was taken from varietal trails in which leaf management treatments (leaf picking and no leaf picking) were the main plots and the cowpea genotypes were the sub-plots. For the leaf picking treatment, cowpea leaf was picked starting at four weeks after planting through to 50% flower. The leaf was weighed fresh, then sun-dried, and then weighed again. At the end of the experiment, all the pods were harvested at maturity and weighed, threshed and then weighed again.

In the market place, beans are sold in the dried state and for the calculations it was assumed that the beans harvested in the trials had a moisture content of 24 % and the dried beans in the market had a moisture content of 12 %.

Results

The market surveys revealed a range of prices and volumes of dried cowpea leaves and beans. In order to have a meaningful compassion, price data was used for leaves and beans that were being sold in the same sized container (cups). It was determined that the weight of product sold was 57 g and 224 g for dried leaf and beans, respectively. This data was used to calculate the returns from the different harvesting treatments on the cowpea varieties (Table 22).

By harvesting both leaf and the beans, the average return over all varieties per hectare was more than when there was no leaf harvested and only the beans were harvested and sold (1,734,973 $ compared to 1,551,262 $). However, this does not take into account the opportunity costs (which may be zero) of having to continually harvest the leaves. The new varieties produced mixed results with some varieties producing greater economic returns from harvesting both leaf and beans and others from only harvesting beans. However, the returns were considerably greater if both leaf and beans were harvested compared to beans alone harvested of the local landraces, ZINYEMBA and LANDRACE. However, most of the new dual purpose varieties would return more income than the local landraces, so farmers should not have any reservations about using the new varieties for both leaf and bean harvesting.

Table 22. Economic impact on leaf harvesting treatment on dual purpose varieties of cowpeas cultivated either for leaf and beans or beans alone.

	Dry leaf		Dry bean with leaf harvest		Leaf + bean income ($)	Dry bean no leaf harvest	
Variety	Yield (kg / ha)	Income ($)	Yield (kg / ha)	Income ($)		Yield (kg / ha)	Income ($)
C/1/5/14	286	501,754	1249	1,114,929	1,616,683	2030	1,812,643
C/7/5/5	315	552,632	1500	1,339,643	1,892,274	1607	1,434,714
C/5/5/18	251	440,351	1217	1,086,643	1,526,994	1965	1,754,500
C/4/5/10	294	515,789	1468	1,310,571	1,826,361	1833	1,636,643
CE82-16	173	303,509	1163	1,038,714	1,342,223	1807	1,613,071
ZINYEMBA	623	1,092,982	334	298,571	1,391,554	198	176,786
CE475/89	281	492,982	1439	1,284,643	1,777,625	2097	1,872,357
C/7/5/23	265	464,912	1315	1,173,857	1,638,769	1773	1,583,214
C/7/5/29	246	431,579	1396	1,246,143	1,677,722	1729	1,543,929
C/2/5/10	242	424,561	1098	980,571	1,405,133	22278	1,988,643
C/33/5/7	310	543,860	1381	1,232,786	1,776,645	19418	1,733,286
C/16/5/1/2	285	500,000	1624	1,450,429	1,950,429	1850	1,651,571
C/26/5/26	264	463,158	1390	1,241,429	1,704,586	1691	1,510,143
C/18/5/18/1	231	405,263	1579	1,409,571	1,814,835	2020	1,804,000
C/31/5/3	282	494,737	1463	1,305,857	1,800,594	1810	1,616,214
C/34/5/4	278	487,719	1654	1,476,357	1,964,076	1850	1,651,571
CBC 1	289	507,018	1362	1,216,286	1,723,303	1843	1,645,286
C/31/5/17	280	491,228	1473	1,315,286	1,806,514	1961	1,750,571
C/20/5/3	328	575,439	1477	1,318,429	1,893,867	1918	1,712,071
C/16/5/5	333	584,211	1417	1,265,000	1,849,211	1825	1,629,571
C/20/5/20	347	608,772	1718	1,533,714	2,142,486	1825	1,629,571
C/21/5/25	352	617,544	1413	1,261,857	1,879,401	1922	1,716,000
LANDRACE	513	900,000	346	308,786	1,208,786	182	162,643
TVX 1948 01F	424	743,860	1440	1,285,429	2,029,288	1793	1,601,286
Mean					**1,734,973**		**1,551,262**

Output 3. Appropriate processing and packaging techniques identified and optimised

The socio-economic surveys reported in Output 1 revealed wide ranging constraints that lead to the limited consumption and utilisation of indigenous vegetables in the urban and peri-urban areas of Mutare, Harare and Bulawayo. The major factors identified were the weaknesses in the marketing systems, limited knowledge and skills on how to prepare vegetables and technological gaps that exist in processing and preservation of the products.

Surveys indicated that there is a high demand for dried vegetables, particularly from cowpea, Cleome and pumpkin, even though quality and packaging need improving. Most of the leaves are processed by sun drying. Several organisations in Zimbabwe are currently adapting solar drying technology to produce dried leafy vegetables.

The Project has collaborated with the Development Technology Centre (DTC) of the University of Zimbabwe to refine and disseminate their drying technology. DTC had successfully conducted a number of projects and identified solar drying to be the most suitable method of preserving/processing indigenous vegetables at rural household level. It was therefore in the interest of this project to assist DTC develop and evaluate appropriate and economic solar drying systems for use by small-scale rural farmers/processors. Emphasis was put on coming up with a system that could dry vegetables within a short period of time into a consistent and light product with a longer shelf life. This approach could overcome most of the constraints identified as being faced by producers and processors in delivering bigger volumes of processed vegetables to markets. The same technology, when properly used, could address most of the concerns of the consumers regarding issues of hygiene, product quality and food safety.

The project took several fronts to explore various methods of processing and marketing solar dried vegetables. Drying trials were conducted at the University of Zimbabwe and at two on-farm sites. The activities at the university focused on developing appropriate drying techniques, drying equipment and best practice extension guidelines for use by participating farmers. Where further processing was required (for example making soups and vegetable juices) relevant technologies available on the market were adopted and processing systems were developed. Packaging techniques and appropriate storage management methods were also explored.

The on-farm trials were focused on determining the farmers' management capabilities of running a solar dryer. A tunnel solar dryer that was developed by the Development Technology Centre of the University of Zimbabwe was used in the trials. Two on-farm sites of different geophysical conditions representing people of different ethnic groups helped to provide information on the performance of the dryer and a site for demonstrations to farmers/processors.

Research activities

Activities were undertaken to:

a) establish research and demonstration sites and undertake performance tests;
b) develop processing information for three indigenous vegetables to include issues of costs and benefits, food safety, hygiene and quality control;
c) develop information guidelines on appropriate storage management methods;

Research and Demonstration Sites

Two on-farm research sites were selected for the solar drying trials in Mashonaland West and Matabeleland South provinces. Selection was based on already existing experiences in vegetable processing. The University of Zimbabwe was taken as an on-station site. Each site was equipped with a tunnel solar dryer and pre-and post processing equipment as listed below. A technical assistant was deployed to each location to offer backup service and on-spot further training.

Processing equipment

Pre-drying	**Post-drying**
dishes/ buckets	Plastic bags
knives	Sealer
pots	Labels
cutting boards	Cardboard boxes
kitchen scale	Storage room
blanching nets	
dishing spoons	
rouser / winnowing tray	
mat	
working table	
stove	
dish towels	

Farmer representatives and extension staff from around both sites were invited to attend a one-week training seminar on vegetable solar drying at the University of Zimbabwe at the inception of the project. Farmers from a resettlement area in Chinhoyi-Mashonaland West and the extension worker for the area managed to attend. It was difficult to get participants from Matabeleland South province, as a final selection for a suitable site had not yet been done due to logistical problems. However, a separate demonstration was later conducted on site.

The seminars were designed to give a good balance between theory and practice of solar drying that covered pre-processing techniques (selection of vegetables for processing, temporary storage systems, cleaning, stripping, cutting and blanching), dryer construction and installation, drying and dryer management principles, assessment of drying process, handling of dried products, grading and packaging. Each participant was accorded an opportunity to practice each and every stage. At the end of the seminar participants were taken on a tour of dried vegetable markets in

Harare and Gwanda respectively. The idea was to create, from the onset, communication links between the market and processors.

Performance tests of the DTC tunnel dryer

The DTC tunnel dryer, schematically presented in figure 9, consists of a clear plastic-covered solar air heating tunnel (solar collector), a drying box and axial flow fans. The floor of solar collector consists of a black plastic that absorbs solar radiation and converts it into heat. The underside of the black plastic is well insulated to avoid losses of heat to the ground. The drying box is covered with a clear plastic that is fixed on one length and left free on the other side to allow rolling up and down when loading and unloading the dryer. The solar collector and the drying box are raised on supporting poles to avoid moisture absorption from the ground and to ease loading and unloading of the dryer. The fans are driven by a solar panel or by mains electricity where applicable. The solar collector is designed in modular form to facilitate transport and installation. On very hot days, when solar collector temperatures are likely to exceed 70 ^{o}C, the dryer is covered with 50% shed-cloth to prevent overheating.

Dryer Temperature

The highest air temperature recorded in the tunnel dryer was 57 ^{o}C. Measurements were taken in the summer period which is generally humid hence higher temperatures are likely to be achieved in the dryer months of September and October. At the beginning of drying (in the morning hours), the drying air temperatures recorded were low and gradually increased by the middle of the day.

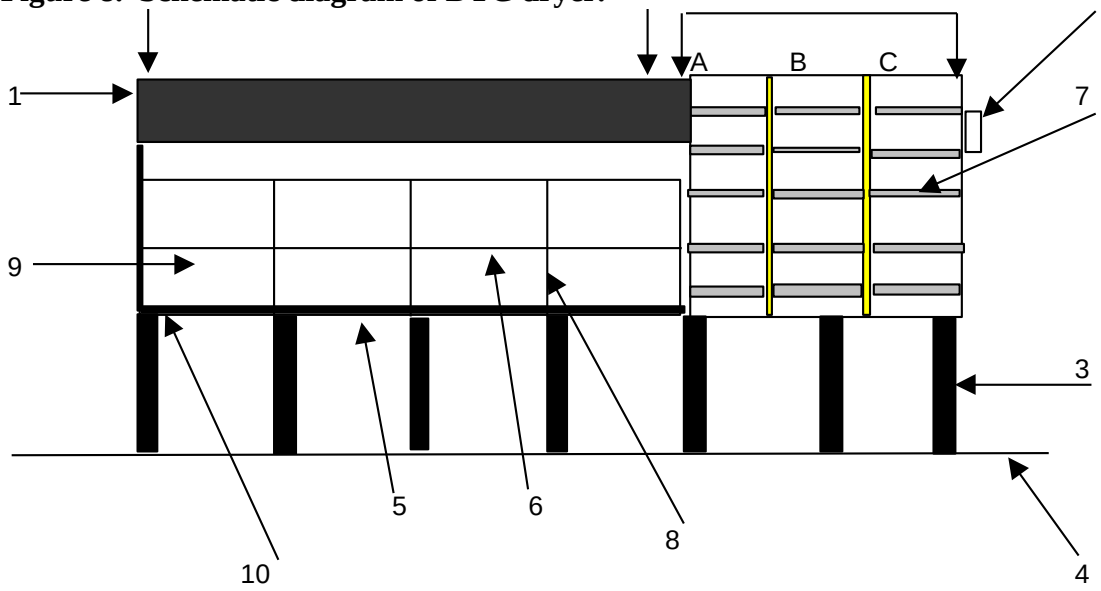
Drying Time

Numerous tests conducted on-station and in the field have shown that the three selected vegetables dry in 1 to 2 hours depending on the radiation available on the day. The crop dried uniformly into a consistent product. However, more work needs to be done to determine the optimum moisture content of the dried products. Basic equipment for pre-processing is widely available in Zimbabwe. Table.23 presents commonly available options for each of the processing stages of the drying operation.

Table 23. Pre processing options

Operation	**OPTION 1**	**OPTION 2**	**OPTION 3**
Washing	Manual in a dish/bucket	Running water	
Cutting	Knives	Multi-knife cutter	Hand strip
Blanching	Dip vegetables wrapped in shed netting in boiling water	Place vegetables in a wire mesh basket over boiling water	
Cooking	Ordinary boiling pot		
Weighing	Kitchen scale	Pack volume	
Bag sealing	Hot sharp edge, e.g. hot wire or hot knife	Commercial bag sealer	
Dryer	Commercial dryers fan assisted air flow	Domestic dryers (low capacity) which depend on natural convection	

Figure 8. Schematic diagram of DTC dryer.



1 shed-netting → protects the absorber from excess heat, when drier is not in use
2 fans → draw warm air from collector over the produce
3 poles → keeps the drier aboveground level , allowing for easy accessibility
4 ground → ancorage of poles
5 black absober → absorbs shortwave radiation and releases longwave which is trapped
6 supporting wires → used to support transparent plastic thus mantaining angle of inclinati ation
7 trays → for loading produce on should not have nettingsthat rust or contamin inate
8 trusses → they are used to support the transparrent plastic that covers the coollector
9 transparent plastic → allows short wave radiation in and taps long wave inside
10 wire gauze → lets in air without big particles that tarnishes the produce
11 drying box → houses the trays as the produce dries
12 collector → collects air from the environment into the drier

TRAY MANAGEMENT

When drier is not in use keep it closed and shed netted. If produce is loaded in the drier it must be constantly checked to avoid over drying of produce. If the trays are not drying uniformly as is the case, the first tray of column A is the first to dry and the last tray on column C is the last to dry. This is caused mostly by warm moist air rising by convection and being drawn across the first tray of column A. This then requires the trays to be shifted periodically thus by first exchanging the two trays mentioned above trays in respective columns are shifted contiously towards the first column and into position 1 of this column . Care must be taken to avoid loading to dry produce on first tray of column C and loading wet produce on first tray of column A as this will cause C to absorb moisture from A.

Guidelines for processing information for three indigenous vegetables, food safety/hygiene and quality control, and costs and benefits.

Guidelines

These guidelines form part of the dissemination materials from Output 4, but are presented here. Pre-processing and processing guidelines were developed in the form of flow charts in English, Shona and Ndebele for the three targeted vegetables: two processing options were prepared for cowpea leaves and three each for pumpkin leaves and spider plant. An example of one of the process flowcharts for drying cowpea leaves is shown in Spreadsheet 1.

Trouble shooting and food quality/hygiene guidelines are presented in spreadsheets 2 and 3.

i) Trouble shooting aspects;

ii) Quality control guidelines.

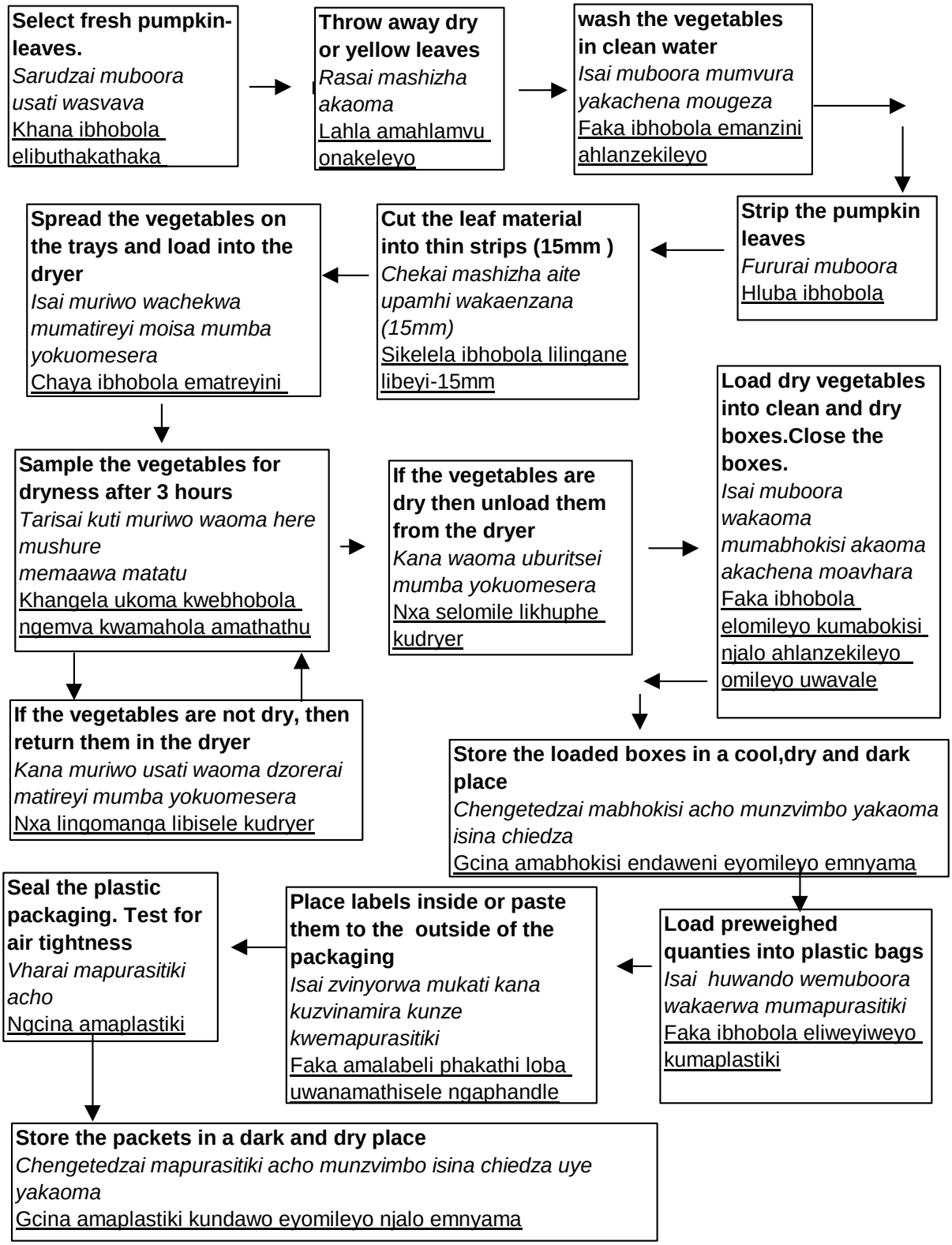
The cost and benefits of drying vegetables

The costs of drying locally-produced vegetables was assessed based on:

- estimated throughput and capacity of the dryer;
- costs of equipment (in terms of depreciated costs);
- variable costs required to produce the final product;
- sales price per packet sold.

It can be seen from the assumptions and calculations detailed in Spreadsheet 4 below that a sale price of 100 Zimbabwe $ per packet (50g) of dried leafy vegetable would be required to break even. Market surveys in Mbare market, Harare should that prices for a tea cup (approximately 55 g) of dried cowpea varied from 80 $ to 150 $ suggesting that returns for processors selling to traders are very slim at that time of year (December 2002 - January 2003). This period coincides with peak fresh leaf sales and prices for dry produce would be expected to rise as the supply of fresh leaf declines. Further price studies are required to confirm these findings.

Spreadsheet 1. Drying pumpkin-leaves/Kuomesa muboora/Ukonyiswa kwebhobola



Spreadsheet 2. Guidelines for troubleshooting

PROBLEM	CAUSE	SOLUTION
Cool air coming out of the dryer	Dryer is open	Close the dryer
	Dryer has leakages	Close the leakages
	Shed-netting covering the dryer	Remove shed-netting
	Dirty dryer plastic	Clean the plastic
	Broken insulation	Repair/Replace insulation
Hot air coming out of the dryer	Over-drying	Unload the produce
		If the dryer is off, cover it with shed-netting
Fans not running	Power off	Switch on power
	Blown fuse	Replace fuse
	Short circuit	Inspect the whole circuit
Discolouration of produce	Direct heat from the sun	Put shed-netting before the top shelf inside the drying box
	Over-ripe fruits	Use fruits at early stage of ripening
	Bruises on produce	Use non-bruised produce
	Yellowish vegetable leaves	Use fresh leaves
	Mixing of produce	Unload the dryer from below
		Always put fruits on the top shelves and vegetables below
Thin dried slices or too small vegetables	Making too small slices	Slice thicker/larger slices
		Do not feed vegetables twice into the cutter
Non uniform drying of vegetables	Uneven spreading of produce	Spread fruits/vegetables uniformly
	Non uniform slices	Cut slices of same thickness
Moisture reabsorption in the dryer	Improper swapping of trays	Swap trays properly
Crushing of produce	Improper handling	Proper handling
	Pilling of packets	Load into boxes before stacking
	Over-drying of produce	Do not over-dry produce
Development of moulds on produce	Contamination of produce	Avoid contamination of produce
	Presence of moisture on produce	Dry to recommended moisture content

Spreadsheet 3. Quality control

PROCESSES

PURCHASING AND SELECTION

select fresh vegetables of good quality
select fruit variety with small seed
do not select overripe fruits
do not buy rot / diseased fruits

GRADING

throw away yellow leaves
cut out all dry parts
cut out all bruised parts

CLEANING

clean vegetables / fruits thoroughly
rinse once or twice and change control

CUTTING

ensure that the cut material is of the same size i.e. :-

mangoes	2 - 3mm
bananas	5mm
tomatoes	3 - 5mm
vegetables	15mm

emphasize consistency of thickness for even drying

BLANCHING

do not exceed the stipulated time
blanch with water at boiling point.

ROLLING

allow water to evaporate from the blanched vegetables
use clean hands /preferably wear clean gloves
use a clean surface to roll on e.g. a clean mat

SPREADING

spread the cut fruit / vegetables evenly on the trays
do not let slices overlap

SAMPLING

check for drying after 2 hours of loading
remove all dry material from the dryer
return non-dry material in the dryer and close the door
if in doubt, return material into dryer.

LOADING

load the dry vegetables /fruits into clean and dry boxes
close the boxes

TEMPORARY STORAGE

store the loaded boxes in a dark and dry place for limited time

PACKAGING AND LABELLING

use a spoon to load the packets
do not crush the dry vegetables
weigh the quantity and place the label

SEALING

test if the sealing is air tight

STORAGE

put the sealed packets in dry and clean boxes
stack the loaded boxes in a dry and dark room

KEY POINTS ON STORAGE

it is good practice to keep a record of what comes into /leaves the storage structure
avoid mixing of old produce with new produce to avoid contamination
produce is to be stored at the lowest moisture level possible
the storage structure is to be kept cool
the storage structures roof is to be well sealed to prevent moisture intake
compartments in the structure should be well sealed
to deny access to rodents and insects
monitor the condition of the produce by inspecting frequently .If any signs of moulds appear discard or dispose of the produce

PRODUCT QUALITY

quality is rarely achieved by accident
it is influenced by variety, packaging, transportation, handling, processing and storage management

Spreadsheet 4. Processing costs (Zimbabwe $) for dried leafy vegetable products

Assumptions:

- cost of a bundle of fresh raw material 600 Zim $, giving 9 packets (50g) per bundle;
- loading capacity equivalent to 130 packets, with two loads per day;
- over the year the dryer would be used 30% of the time.

Therefore throughput of dryer for one year would be 28,470 packets.

Fixed Costs

Dryer Equipment	Quantity	Unit cost	Total cost
dryer	1	250000	250000
dishes	3	1500	4500
buckets	1	1500	1500
rusero	1	400	400
knife	2	625	1250
cutter	1	25000	25000
cutting board	2	1000	2000
boxes	8	80	640
sealer	1	100000	100000
scale	1	6000	6000
Total			**391290**

Variable costs per day

Variable costs	Quantity	Rate	Total costs
vegetable cost	260	66.7	17333
labour	260	6	1560
packaging	260	4	1040
transport (inputs)	24	100	2400
transport (outputs)	4	100	400
electricity	0.36	5	1.8
Total			**22735**

Overheads - depreciation

Equipment	Cost
dryer(5 y)	50000
cutter (5y)	5000
sealer (3y)	33333.3
scale(3y)	2000
Depreciation/packet	**3.1729**
Minor equipment replacement every 3 months	
Total cost	10290
Annual depreciation	41160
Depreciation/packet	**1.4457**

Other costs

Annual salary	150000
Salary cost/packet	**5.2687**
Storage cost per year	24000
Storage costs per packet	**0.8430**

Costs per packet

Total variable costs per packet	87.44
Total overhead costs per packet	10.73
Total costs per packet	**98.17**

Effect of retail price on daily net profit

retail price per packet	daily gross income	daily gross profit	daily net profit
30	7800	-14935.13	**-17725**
50	13000	-9735.133	**-12525**
100	26000	3264.867	**475**
150	1200	1200	**1200**
200	52000	29264.87	**26475**

Output 4. Promotion and dissemination of project outputs.

The promotion and dissemination of project outputs has centred on:

- distribution and sale of improved seed with improved characteristics;
- preparation of information of key traditional vegetables covering crop establishment, harvesting and processing outputs of the project;
- field days and demonstration sites.

Distribution and Sale of Improved Seed

The uptake of new germplasm produced by the project has aimed to develop effective seed delivery systems accompanied by appropriate knowledge.

The project is currently disseminating seed to farmers through the Horticulture Research Centre and a private seed company (East-West Seed) for Cleome, Corchorus, Brassicas and Okra, and through the Department for Research and Specialist Services for new cowpea dual-purpose varieties.

Information booklets and leaflets
The distribution of seed is accompanied by information on the commodities. Technical booklets and farmer leaflets have been prepared for dual-purpose cowpea, Cleome, Corchorus, Brassica, okra and bottle gourd. An example of the leaflet for cowpea is presented in Appendix 1.

As indicated above in Output 3, demonstration solar dryers and leaflets have been completed to guide the processing of cowpea, spider plant and pumpkin leaves.

Field days and demonstration sites
The dissemination of the improved cowpea varieties was accompanied by a national field day at Matopos Research Centre with press and TV coverage.

To disseminate drying technologies, training seminars have been held for farmers/processors and extension officers and two on-farm and one on-station demonstration sites have been established.

Contribution of Outputs to Project Purpose

The outputs of the project have mostly been achieved with the principal vegetable types, as identified by the surveys, being assessed and seed disseminated. Seed with improved characteristics have been produced and cultivation and harvesting systems have been improved to increase the productive potential. Seed has begun to be distributed through project partners. However, for reasons outside of the project's control, the project was not able to disseminate the findings as widely as possible in Zimbabwe, particularly in rural areas. Associated with this was the difficulty in developing community seed banks and other seed multiplication and distribution systems outside of the public organisations and the Seed Company that the project was working with.

Publications:

Chigumira Ngwerume, F. and Marongwe E. (2002). Traditional vegetable development programme. In: Post-Harvest Bulletin. Oct - Dec 2002 Quarterly Publication of the Crop Post-Harvest Programme (Southern Africa). 8 - 10.

Mvere, B. (2002) Effect of Harvest Maturity and Fruit Coatings on the Shelf-Life of Three Bottle Gourd [*Langenaria siceraria* (Molina) Standley] Varieties Stored under Ambient Conditions. MSc Thesis, University of Greenwich, United Kingdom. pp 107

5. Internal Reports:

Gwenero, E., Dube, B. and Ngwerume, F. C. (2000). Report on the findings of a socio-economic survey on the marketing, consumption and production of traditional vegetables in the urban and peri-urban areas of Bulawayo, Zimbabwe. Report of the Horticulture Research Institute, Marondera, Zimbabwe and The Natural Resources Institute, UK. pp 23

Ngwerume, F. C., Gwenero, E., and Dube, B. (2000). Needs Assessment From The Socio Economic Survey On The Production, Marketing And Consumption Of Traditional Vegetable Crops In The Urban And Peri Urban Areas Of Bulawayo. Report of the Horticulture Research Institute, Marondera, Zimbabwe and The Natural Resources Institute, UK. pp 6.

Ngwerume, F. C. and Mvere, B. (2000). Report on the findings of a socio-economic survey on the marketing, consumption and production of traditional vegetables in the urban and peri-urban areas of Harare, Zimbabwe. Report of the Horticulture Research Institute, Marondera, Zimbabwe and The Natural Resources Institute, UK. pp 23.

Ngwerume, F. C. and Mvere, B. (2000). Needs Assessment From The Socio Economic Survey On The Production, Marketing And Consumption Of Traditional Vegetable Crops In The Urban And Peri Urban Areas Of Harare. Report of the Horticulture Research Institute, Marondera, Zimbabwe and The Natural Resources Institute, UK. pp 8.

Mutimutema, E and Mvere, B. (2000). Report on the findings of a socio-economic survey on the marketing, consumption and production of traditional vegetables in the urban and peri-urban areas of Mutare, Zimbabwe. Report of the Horticulture Research Institute, Marondera, Zimbabwe and The Natural Resources Institute, UK. pp 24.

Mvere, B and Mutimutema, E. (2000). Needs Assessment From The Socio Economic Survey On The Production, Marketing And Consumption Of Traditional Vegetable Crops In The Urban And Peri Urban Areas Of Mutare. Report of the Horticulture Research Institute, Marondera, Zimbabwe and The Natural Resources Institute, UK. pp 9.

Anon. (2001). Proceedings of the Workshop on Promoting the Use of Fresh and Processed Indigenous Vegetables in Zimbabwe. St Lucia Park, Organisational Training and Development Centre, Harare, Zimbabwe. Report of the Horticulture Research Institute, Marondera, Zimbabwe and The Natural Resources Institute, UK. pp 51

Anstee, G. (2001). Traditional vegetables of Zimbabwe: Appropriate processing, storage, and packaging technologies. The Natural Resources Institute, UK. pp 18.

Mvere, B. (2001). A Review of Post-Harvest Handling and Marketing of Traditional Vegetables in Zimbabwe: Current Practices, Constraints and Opportunities. Report of the Horticulture Research Institute, Marondera, Zimbabwe and The Natural Resources Institute, UK. pp 27.

Schippers, R. R. (2001). *Corchorus* species found in Zimbabwe. The Natural Resources Institute, UK. pp 8.

Mvere, B. (2001). A review of cowpea [*Vigna unguiculata* (l.) Walp.]: Utilisation and cultivation in Zimbabwe. Horticultural Research Centre, Marondera, Zimbabwe. pp 5.

Madamba, R. (2002) Evaluating leaf, grain yield and nutritive value of different cowpea varieties, preliminary report. Interim Report. DRSS, Crop Breeding Institute. Harare, Zimbabwe and Natural Resources Institute, Chatham, UK. pp 5

Mukwereza, L. (2002). Marketing Opportunities for Processed Indigenous Vegetables (IV's): Report on the Bulawayo market and its peri-urban areas. AGRITEX, Harare, Zimbabwe and Natural Resources Institute. Chatham, UK. pp 5.

Mukwereza, L. (2002). Report on the Study on Processed Indigenous Vegetables (IV's): Mutare city and its Peri-urban areas AGRITEX, Harare, Zimbabwe and Natural Resources Institute. Chatham, UK. pp 16.

Mukwereza, L. (2002). Marketing Opportunities for Processed Indigenous Vegetables (IV's): Report on the Bulawayo market and its peri-urban areas. AGRITEX, Harare, Zimbabwe and Natural Resources Institute. Chatham, UK. pp 5.

Mutimutema, E. S. (2002) Peri-Urban Indigenous Vegetable Production In Manicaland. APEX, Mutare, Zimbabwe and Natural Resources Institute, UK. pp 8.

Mvere, B. and Mutimutema, E. S. (2002) The Status Of Spider Plant [*Cleome gynandra*, (*Nyevhe, Runi*)] In Mutare, Zimbabwe. APEX, Mutare, and East-West Seed Company, Harare, Zimbabwe and Natural Resources Institute, UK. pp 8

Ngwerume, F. C. (2002). Report on Traditional Vegetable Crop Development Programme: Improvements to Corchorus, Cleome and okra. Pp

Mukwereza, L. and Kwaramba, J. (2003). Seed Supply to Smallholder Farmers in Zimbabwe: Challenges in Improving the Informal Seed Systems. AGRITEX, Harare, Zimbabwe and Natural Resources Institute. Chatham, UK. pp 22.

6. Other Dissemination of Results:

Madamba, R. (2002) Producing Cowpea Seed. Handbook. Eds. Patience Nyakanda and Danisile Hikwa. Crop Breeding Institute. Department of Research and Specialist Services. Harare, Zimbabwe. Extension leaflet. pp 6.

Ngwerume, F. C. (2003). Commercial Production Of Okra-*Derere/Idelele-Abelmoschus esculenta*. Agricultural Research and Extension, Horticultural Research Institute, P O Box 810, Marondera, Zimbabwe. Extension Booklet pp 7. And extension leaflet pp 1.

Ngwerume, F. C. (2003). Growing *derere re gusha-Corchorus olitorius*-for the urban markets. Agricultural Research and Extension, Horticultural Research Institute, P O Box 810, Marondera, Zimbabwe. Extension Booklet pp 7. And extension leaflet pp 1.

Ngwerume, F. C. (2003). Commercial production of *nyevhe – ulude* –spider plant, cat's whiskers. Agricultural Research and Extension, Horticultural Research Institute, P O Box 810, Marondera, Zimbabwe. Extension Booklet pp 8. And extension leaflet pp 1.

Ngwerume, F. C. (2003). Commercial production of Tsunga – *Brassica juncea* and Chembere dzagumhana-*Brassica carinata.* Agricultural Research and Extension, Horticultural Research Institute, P O Box 810, Marondera, Zimbabwe. Extension Booklet pp 10. And extension leaflet pp 1.

Mhazo, N. and Nazare, R. (2003). Guidelines for processing leafy traditional vegetables. Development Technology Centre, University of Zimbabwe, Harare, Zimbabwe.

Appendix 1

PRODUCING COWPEA SEED

Written by

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Edited by
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.
The Crop Breeding Institute

September 2002

Preface

The Crop Breeding Institute is a government institution under the Department of Research and Extension, in the Ministry of Lands, Agriculture and Rural resettlement. It is responsible for developing and releasing improved varieties of maize, soybean, groundnuts, sunflower, wheat, bean, cowpea, bambara groundnut, potato and barley which is done in collaboration with National Breweries Private Limited.

Crop Breeding Institute. Department of Research and Specialist Services.
P.O. Box CY 550, Causeway, Harare, Zimbabwe.
Tel: 263 4704533/9.Fax: 263 4728317

This handbook provides some general information on producing cowpea seed. It is also available in Shona and Ndebele for use by all farmers in Zimbabwe.

Agronomic practices in cowpea seed production are the same as those for producing cowpea grain. The information given in this handbook can also be used in cowpea grain production. However, there is a need to take care to produce seed of good quality to meet seed standards.

The handbook is available on request from the Crop Breeding Institute and The Districts' Extension Offices in all provinces.

Classes of seed

This information is important to farmers who want to produce good quality seed either for their own production or for business opportunities.

There are two classes of seeds that can be sold in Zimbabwe, certified seed and standard seed. In producing certified seed farmers have to be registered as

seed growers by a certifying authority such as Seed Services. The planting material should be of known origin, fields are inspected, and germination and purity tests are carried out. Seed of cowpea can be sold as standard seed if it does not meet seed certification requirements. However, it is important to know whether the seed germinates or not. Purity and germination tests have to be done before the seed can be sold as standard seed.

Quality of seed

Farmers should aim to get good quality seed necessary to produce a good yield.

Good quality seed:

1) has a high germination or emergence rate,
2) is well dried so that it does not get rotten,
3) is pure, all seeds are of the same variety,
4) is clean, not mixed with foreign matter like stones, dirt or weeds,
5) is not damaged, broken, shriveled, rotten or diseased.

Quality standards for seed

The standard for good quality cowpea seed is:

- **Certified Standard Germination percentage by count80%;**
- Pure seed by mass 99%;
- Moisture by mass 13%;
- Off-types by mass0.5%;
- Damaged seed by mass 5.0%;
- Insect damaged by mass 3.0%;
- Foreign matter by mass 1.0%;
- Weed seed by mass0.5%;
- Other crop seeds by mass0.5%.

Farmers should aim to have seed that at least meets the above standard to have good yield.

Soil and rainfall requirements

Cowpea can be grown in any soil. However, it does best in well-drained sandy loam to clay loam soils. It requires about 250 to 500 mm of rainfall that is evenly distributed.

Site selection

Select good fields for seed production. Avoid areas that are water logged, have weed problems and were previously grown to cowpea in the past three years.

Field preparation

Cowpea requires fine tilth to germinate. Plough the field before planting. If the field has a lot of weeds, plough it at least one month before planting to allow all the material to rot.

Soil fertility management

If possible send the soil for analysis and use the fertilizers recommended – **get advice from the area extension officer on how to do this**. Cowpea fixes nitrogen and hence does not require ammonium nitrate. As a general guide, if there are no soil analysis results, use 120 to 240 kg per acre (300 to 600 kg/ha) of lime in acid soils. Soil acidity is a major problem to the sandy soils of Natural Region II. Add 60 to 90 kg per acre (150 to 225 kg/ha) of single super phosphate in soils lacking phosphorus. This will improve yields. Cowpea does well after maize.

Planting

It is necessary to grow the seed cowpea crop on its own, not mixed with maize or other crops. This allows proper management of the crop. Source of planting seed is important. Plant clean, good quality seed obtained from a known source.

Sow 8 to 12 kg per acre (20 to 30 kg/ha) of cowpea seed. If the seed is untreated, seed dress with thiram at a rate of 35g/50 kg seed before planting. This controls seedling diseases. **Get advice from area extension officer when using chemicals.**

Plant cowpea in rows. This makes it easier to weed and rogue (remove) off types. Off types are plants that are different from your cowpea seed crop. Use a spacing of 15 cm between the plants and 45 cm between rows.

☐ 15cm ☐ 15cm ☐ 15cm ☐ 15cm ☐

45 cm

☐ 15cm ☐ 15cm ☐ 15cm ☐ 15cm ☐

When planting two different cowpea varieties in one field leave a space of 3m in between them. This prevents mixing with other varieties at harvesting.

☐☐☐ 3m ☐☐☐

☐☐☐ ☐☐☐

☐☐☐ ☐☐☐

Variety 1 **Variety 2**

Planting time

In drier areas, early planting with the first rains in November allows the crop to mature before the end of the rains. In high rainfall areas plant in December and try to avoid early planting as the crop will mature during the rain season. This will cause pod rotting resulting in poor seed quality.

Weeding

Weeds reduce yield and quality of seed. Weed within 4 weeks after planting. Thereafter weeding will depend on growth of weeds in the crop. Dual, a pre-emergence herbicide, at 0.7 l per acre (1.75l/ha) can be used to control weeds.

Roguing

It is important to have a pure crop. Remove all plants that look very different from the variety you have grown (off types). This is called roguing. These plants, for example, could differ in plant height, leaf shape or colour, or flower colour. Rogue at 4 weeks after planting just after the first weeding, at flowering and when the plants have pods.

Controlling diseases

The most common diseases that affect cowpea plants are bacterial leaf blight, Ascochyta blight and scab. Copper oxychloride and benomyl are some of the chemicals that can be used to control cowpea diseases. **Get advice from the area extension officer.**

Controlling insect field pests

Aphids, thrips, pod borers and pod sucking bugs are the major field pests. These pests can be controlled by spraying the crop with some of these chemicals: dimethoate (rogor), endosulfan and cypermethrin. **Always get advice from area extension officer when using chemicals.**

Harvesting

Harvest the pods when they are dry. However, when the crop matures during the rainy period, more than one picking is necessary to avoid rotting of pods.

Drying

Dry pods easily break and separate from the seed. The pods can be sun-dried on a mat, rock or area that has between smeared with dung, so that they do not get dirty or wet. Watch the cowpea as they dry to safe guard against animals. Quickly remove the cowpea or put a cover on top when it rains. Wetting the cowpea pods cause pod rots and sprouting.

Threshing

Thresh the pods when they are completely dry. During threshing it is important that the seed is not damaged or mixed with dirt. Winnowing should be done to separate chaff, dust and trash from the seed.

Sorting the seed
Remove shriveled, diseased, broken and seed of other varieties. This can be done using a winnower and finally by hand.

Seed moisture content
Store seed that have been dried to moisture content of less than 13% so that it does not rot when in storage. Seed moisture content can be determined by using the salt test. For this you need a small glass jar (jam or peanut butter containers can do) and salt. Take a small seed sample from the middle of the bag. Put salt in the jar until it is a quarter full. Add the seed sample, to fill up to half the jar and close tightly with the lid. Shake the jar well and allow the seed to settle for about 10 minutes. If damp salt is stuck on the sides of the jar, the seed is too moist. If no salt is stuck on the sides, the seed is dry.

Seed treatment
Treat the seed to protect it from damage by insects, rodents and moulds. Cowpea weevil is the major problem in storage. Some local treatments that are used against weevils during storage include frequent drying in the sun, mixing with wood ash, finger millet chaff, gum tree leaves, hot spices and coating with cooking oil.
Treatment with chemicals is more effective. Some of these chemicals can be used in storage: malathion dust, aluminium phosphide tablets, actellic dust and copper shumba. **Always get advice when using chemicals from area extension officer.**

Seed storage
Store the seed well to avoid damage. The container that is used for storing the seed should be clean and dry. Disinfect the containers by washing with clean water and dipping them in boiling water for five minutes. Polythene bags, clay pots, drums or tins that close tightly can be used as storage containers.

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