Nutrition Garden
Bag Gardens
for sukuma wiki, amaranth and pumpkin

This publication was produced by Real Impact under the USAID-funded Kenya Horticulture Competitiveness Project (KHCP).

Real Impact NGO

Real Impact is a charitable NGO which promotes Nutrition Gardens and healthy diets, using sustainable farming methods. See our website for details of training courses (kitchen gardening and cooking courses) at our farm and canteen in Thika, Kenya. We have a range of courses suiting various clients from either rural or urban households, institutional gardeners and chefs, NGO extension staff and agronomy advisors.

USAID-Kenya Horticulture Competitiveness Project (KHCP)

KHCP is a 3-year program to increase smallholder farmer incomes through enhanced productivity and improved domestic and export marketing of agricultural products. The long-term impact of the project is sustainable increases in rural incomes and food security with higher nutritional standards. The Real Impact programme focuses on nutrition first, with a secondary benefit to livelihoods through the sale of any surplus.

Why is a Nutrition Garden needed?

According to World Health Authority (WHO) data, there are severe vitamin A and iron deficiencies in traditional East African diets, which are over-reliant on maize. Maize meal has no vitamin A or iron. Vitamin A deficiency is the main cause of avoidable blindness in children and severely affects the immune system allowing children to die of simple childhood diseases. Over-consumption of maize meal and sugar is the primary cause of diet-related Diabetes type 2 from which more than 25% of the population can suffer, and which can lead to ulceration and eventual amputation of legs, due to poor blood circulation.

These and other deficiencies (selenium, zinc, protein and calcium) can easily be cost-effectively addressed by vegetables produced in Nutrition Gardens, linked to Nutrition Kitchens which promote nutritionally balanced menus.

More Information

This leaflet is part of a series of technical leaflets available from Real Impact as part of their training courses.

Leaflet 1:	Introduction to Nutrition Gardens
Leaflet 2:	Bag Gardens (*sukuma wiki, amaranth and pumpkin*)
Leaflet 3:	Root crops grown in beds (*carrots, leeks, sweet potato*)
Leaflet 4:	Leafy crops grown in beds (*spinach and cabbage*)
Leaflet 5:	legume crops grown in beds (*French beans*)
Leaflet 6:	Fruit trees and perennial coppice (*matoke and sweet banana and Moringa*)
Leaflet 7:	Pile compost, solid vermi-fertiliser and vermi-liquid fertiliser production.

Real Impact has also published a **Nutrition Garden Cook Book** which utilises the 12 nutrition super-food crops in the Nutrition Garden. The development of the cook book was funded by the USAID Tanzanian Agriculture Productivity Programme (TAPP) and the Real IPM Company (Kenya) Ltd.

Volunteers

Real Impact offers a limited number of volunteer positions for experienced health professionals and agronomists wishing to contribute to our field work with schools, self-help groups, orphanages, hospitals, dispensaries, women's and youth groups. Terms and conditions apply – please see our website for more information. www.realimpact.or.ke

Why grow in bags?

Some crops can be grown in bags either to:

- increase the production per meter square of ground
- reduce the amount of water needed to grow the crop and facilitate use of waste household water.
- reduce the amount of time needed to weed crops
- prevent volunteer weeds from the previous crop
- bring crops near to the home to reduce theft and ensure regular crop husbandry.

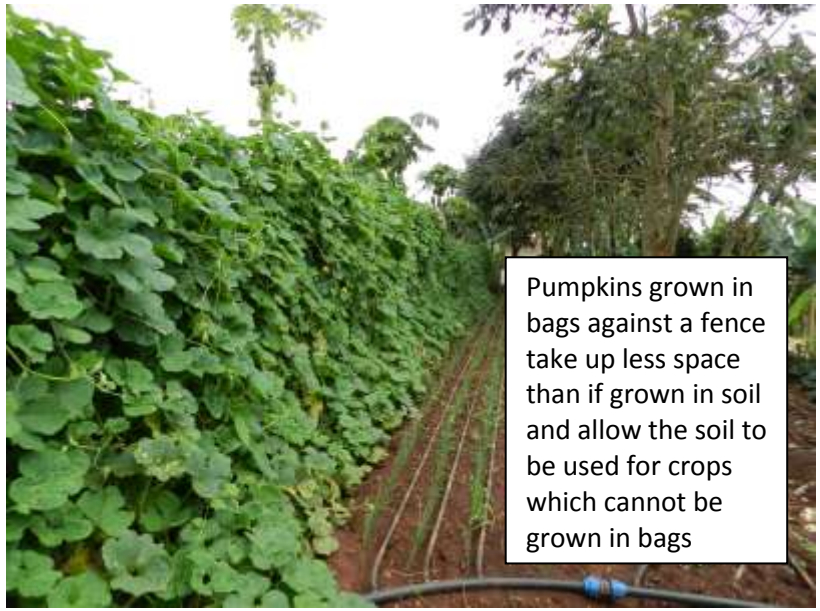
Only three crops in the Nutrition Garden are grown in bag gardens:

- sukuma wiki (kales)
- amaranth
- pumpkin

Higher yields are obtained by growing the other Nutrition Garden crops in the ground (carrots, spinach, cabbage, fine beans, sweet potato, bananas and Moringa)

Amaranth leaf crop in a bag garden avoids the problem of volunteer amaranth weeds from the many seeds it can produce and leave behind when it is grown in the ground (see opposite)

A bag garden occupies only one meter square of land. A bag garden of sukuma wiki can be grown with 60 plants per bag garden compared to only 6 plants per m.sq, if grown in the soil. This is a ten-fold increase in productivity.
(see opposite)



Pumpkins grown in bags against a fence take up less space than if grown in soil and allow the soil to be used for crops which cannot be grown in bags

Why grow sukuma, amaranth and pumpkin?

Pumpkin: The flesh can be cooked as a vegetable, or dried and made into flour (below left). The leaves can also be eaten as a leafy vegetable. Pumpkin seeds are a nutrition snack food and can also be incorporated into pumpkin flesh flour – making it a nutrition super food. For cooking methods and recipes refer to the Nutrition Garden Cook Book.

Pumpkin (above right) is easy to grow and is very rich in vitamin A, protein, iron and zinc. It is therefore very good for the immune system.

	Protein	Vit A	Vit C	Vit B6	Vit B12	Vit E	Iron	Calcium	Selenium	Zinc
pumpkin seeds	66	8	3	4	0	0	83	4	8	50
pumpkin leaves	5	32	2	10	0	5	18	4	1	1
pumpkin flesh	1	100	8	2	0	4	3	1	0	2
pumpkin and seed flour	66		8	4	0	0	83	4	8	50

Table 1: % RDI from 100 grams of cooked pumpkin produce

Sukuma wiki: Also known as 'kales', this is a traditional vegetable, very easy to grow and can crop over a long period by continually plucking individual leaves. It is commonly grown in Kenya.

Amaranth (terere): This indigenous leafy vegetabe is not only a common weed, but breeding programmes have developed this plant into a vigorous leafy plant and also a source of highly nutritious flour made from the seeds.

Amaranth is very easy to grow and can crop over a long period by continually plucking individual leaves. It is commonly grown in Kenya.

To mainatin the excellent nutritional value of both amaranth and sukuma wiki , it must be cooked correctly. Generally, green leafy vegetables should be steamed rather than boiled and not sliced, as this allows too much nutrition to leak into the cooking pan, rather than being retained in the leaf and eaten. See Real Impact Nutrition Garden Cook Book for more information

	Vit A	Vit B6	Vit C	Iron	Calcium
kales (sukuma)	272	7	68	5	7
spinach	241	7	4	20	15
spider plant (saget)	72	8	70	18	15
amaranth (terere)	55	9	69	13	21
pumpkin leaves	32	10	2	18	4
cabbage	2	6	62	1	5
nightshade (managu)	0	6	41	5	15

Table 2: % RDI from 100 grams of cooked leafy vegetables

Nutrition Garden Bag Designs

Free-standing square bag

Real Impact has developed a new bag design in collaboration with Shadenet Ltd in Thika. The new square bag does not need a central pole to support it as the square shape distributes the pressure of the soil held inside the bag, evenly on all bag walls.

The shade net has a UV light inhibitor to prevent the material from degrading quickly under high UV light conditions. It is likely to have a life of up to 15 years.

The planting holes have been already made in the side of the bags, using a heated cutting device that melts the material and seals the rim of the planting hole to prevent the material from tearing.

A small water tank with drippers attached to a valve provides a constant small amount of water to the plants in the bag. Whilst the porous nature of the bag ensures that excess water does not accumulate at the base of the bag and limit plant growth through water-logged conditions.

The bag is placed on a drainage channel in the soil, made before positioning the bag on top of it. The drainage channel takes any excess water to a shade tree nearby. This shade tree could be a Moringa tree, grown for its beans rather than it leaves.

Supply of free-standing bags

Bags can be ordered from Real Impact NGO. Orders can be made via sales@realimpact.or.ke Cash with order sales only. All proceeds to Real Impact Nutrition Garden Projects.

Pole-supported round bag

A second hand 'unga bag' (50 kg flour bag) made of woven plastic threads can be used at least once to make a bag garden. . This is the most common type of bag garden in Kenya.

Drawbacks:

- The bags disintegrate under high UV light conditions and can only be used once or twice.
- It will fall over, when full of soil and water, unless it has a central pole to hold it up – which adds cost and is eventually eaten by termites.
- In addition to the central pole it also needs a column of gravel or nutshells etc, around the pole to act as a drainage column. Water is applied to the top of the bag and allowed to drain to the bottom through the drainage pillar.
- The drainage column and the pole take up valuable space in the bag which could otherwise be used to provide good soil and extra room for the growth of plant roots.

Benefits

- Second hand bags only cost about 20/- Ksh and are reasonably easy to source.
- A pole can be cut from local trees, but costs about 250 Ksh if purchased.

Preparation of pole-supported round bag

Step 1

Place a plastic sheet on the ground for preparation of the growing media.

Step 2

Each bag needs:

1. 14 kg* compost
2. 14 kg top soil/forest soil
3. 14 kg dry manure
4. 2.5 kg vermi-fertiliser
5. 400 g **DAP fertiliser
6. 6 kg of gravel
7. one wooden post 1.5 m and 10 cm diameter
8. one 50 kg used flour bag
9. 60 transplants

*one gorogoro tin = 2 kg
**handful = 100 g 1 jam jar = 400g

Step 3

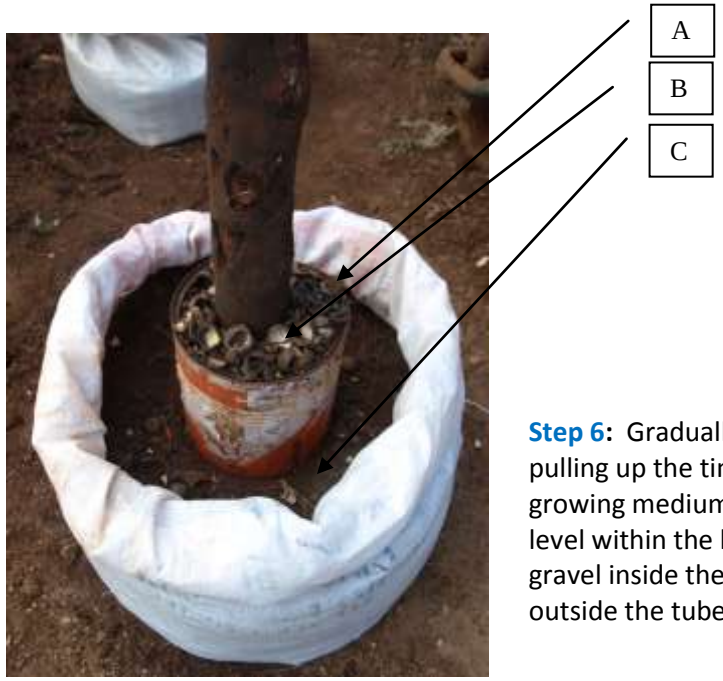
Mix ingredients (1-4) together. Add the DAP (when filling the bag), to the edge of the bag (near plant roots) by sprinkling small amounts at each level.

Step 4

Erect the 2.5 m post with 25 cm into the ground, piercing the base of the bag. The post forms the frame to prevent the bag from falling over when it is full of soil and plants.

Step 5 (see below)

Thread a tin tube or old bucket 20 cm diameter (old tin with the top and base removed) over the post – to form a circular sleeve for holding the drainage column, full of gravel. Fill the inside of the sleeve (A) with gravel (B) and fill the flour bag with the growing media mix and fertilisers (C)



Step 6: Gradually fill the bag by pulling up the tin tube out of the growing medium to fill the next level within the bag with more gravel inside the tube and compost outside the tube.

Step 7: Gradually remove the tin tube used to make the gravel drainage column. Then the bag is ready for planting (see above)

Step 8: Mark 60 small crosses on the outside of the bag, spacing them evenly, all the way around the bag. Carefully make a sharp cut to open up the cross and the planting hole. Transplant the 4 week old seedlings into the hole – making sure they were well watered before planting and that the roots are straightened out (not curled up). (see opposite)

Irrigation

Water is applied by bucket to the open top of the bag and it is allowed to drain down throughout the bag so that all plants are irrigated. The central drainage column helps to get water to the plants at the base of the bag.

After making the bags, they need to be fully 'wetted-up' with a heavy irrigation of 30 litres of water. Apply water until the water drains out of the base of the bag.

Thereafter apply 20 litres of water every other day, depending on the weather – if it is overcast and the plants are not wilting (apply 20 L only every 3 days) – if it is very hot and the plants are wilting, apply 20 litres of water per day.

Fertilisers

The DAP which was applied at planting will run out within about 4 weeks and top-up nitrogen will need to be applied.

This can be achieved by applying a 1% solution of urea. Mix 200 g of urea (half a jam jar) in the 20 litres of water before applying as a drench to the top of the bag. This is enough to treat 2 – 4 bags (depending on the size of the plants). Do this once per week.

If the leaves are not large and dark green, it means they are short of nitrogen. In addition to the above programme, a 1% foliar spray of urea can be applied directly to the leaves where it is taken up very quickly. Spray this using a knapsack sprayer. Spray to wet all the leaves – one knapsack may treat 40 mature bags with large leaves. Only spray urea onto mature plants to avoid scorch). Spray weekly until the leaves green-up.

Cost of Fertilisers

DAP – 3,600 Ksh per 50 kg
CAN – 2,200 Ksh per 50 kg
Urea - 2,600 Ksh per 50 kg

Poor quality CAN does not dissolve easily – use this in the soil for the crops grown in beds (not bags)

Harvesting

The bags are planted up with small plants, already 4 weeks old, so that they will be big enough to begin harvesting individual leaves within about 6 weeks.

These plants can be continuously harvested for another 14 weeks, providing they are properly irrigated, fertilised and harvested. The crops need to maintain a certain number of leaves which will produce the energy to grow more leaves to be harvested. If too many leaves are harvested, the subsequent leaves will be small and the harvest will be low.

As a rule, try to leave 1- 2 fully expanded leaves per sukuma wiki plant to feed the plant and promote continuous growth and only harvest the 'third' leaf on the plant (i.e. the oldest of the three large leaves on the plant).

In order to keep the amaranth plant producing more leaves, all the flowers must be harvested every day. Otherwise the energy of the plant goes into producing seeds, not leaves. The plucked flowers can also be used, by feeding to chickens or steamed and added to the amaranth leaves in recipes. They are too nutritious to be put onto the compost heap.

Yield

Each bag has 60 plants. If 2 leaves can be harvested from each plant per week, this will amount to 120 leaves per bag per week. A sukuma wiki leaf weights about 20 grams and a sprig of amaranth leaves will weigh about 10 grams. This provides a weekly harvest per bag of 2.4 kilos of sukuma wiki leaves or 1.2 kilos of amaranth leaves.

The total harvest period should be limited to about 14 weeks, after this time the leaf size and quality drops and the grower should be harvesting from younger bag gardens. The total harvest over 14 weeks will be 33.6 kilos (sukuma wiki) and 16.8 kilos (amaranth).

Serving size per person

A serving size of sukuma or amaranth per person is up about 60 grams. So one sukuma wiki bag, yielding 2.4 kilos per week is enough to feed 20 people twice per week with a serving of 60 grams each. One amaranth bag would feed 20 people, 60 grams, but only once per week.

Planting Programme

Try not to keep an individual bag 'going' for more than 14 weeks. Instead have a planting programme for new bags which ensures a continuous supply of good quality leaves from younger plants.

Since the first leaves are not ready for harvest for at least 6 weeks after planting - the new plantings should be staggered to ensure a more continuous harvest. The next set of bags should be planted six weeks before the previous set of bags is expected to 'finish' (i.e. 14 weeks after the first set of bags is planted).

A new set of bags should be planted every 14 weeks.

The number of bags to be planted depends on the number of people to be fed and the number of servings per week that need to be provided.

> If the farm must feed 100 people with 60 grams of sukuma, per person, twice per week. This requires 12 kilos of sukuma wiki per week.
>
> Each sukuma wiki bag can produce 2.4 kilos per week, so the farm must have five bags in good production to feed 100 people with 60 grams twice per week (12 kilos ÷ 2.4 kilos = 5 bags)
>
> If the farm must feed 100 people with 60 grams of amaranth each, twice per week. This requires 12 kilos of amaranth per week.
>
> Each amaranth bag can produce 1.2 kilos per week, so the farm must have ten bags in good production to feed 100 people with 60 grams twice per week (12 kilos ÷ 1.2 kilos = 10 bags)

Storage

Fresh sukuma leaves should be bunched (20 per bunch) and can be stored for about 3 days only if kept at 5 ˚ C in a fridge or charcoal cooler. If placed in a large plastic bag with plenty of extra air and sealed (like a balloon) with half a cup of water inside, this can prolong the shelf life for 1-2 days, if kept cool and dark.

Drying

Clean leaves can be sliced into one inch wide ribbons, placed on shelves made of shade net and allowed to dry in the air in the shade for 2 – 3 days. Spread them out, so that they are not more than 2 inches deep, to speed up the drying process. Ensure animals and insects cannot damage them during this period. When leaves are dry they can be put into clean, dry sacks or clay pots for storage in a cool dark place. Ensure the pots and sacks are kept in a vermin-free area and properly closed.

See Cook Book for more information on dehydration, storage and use of vegetables.

Husbandry tips for sukuma wiki and amaranth

Both these plants require the leaves to grow well to harvest high yields.

- Nitrogen and water supplies need to be optimum to ensure the leaves are able to grow large. If the green colour of the leaves is pale green, the plants may need nitrogen feed. See guidelines above under 'fertilisers'.

- Keep a close eye out for caterpillars and bird damage and take action quickly. Pick off caterpillars and put out shiny objects and ribbons to move in the wind and scare off the birds.

- If the weather conditions are very hot and dry, or there is a strong prevailing wind, the leaves may remain small because the plant is suffering water stress (from increased evapo-transpiration from the leaf surface). This can be reduced if the bags are shaded or a wind break is put up.

Pest and disease sprays for amaranth and sukuma wiki

Amaranth does not suffer from many pests and diseases and may not need spraying. If caterpillars attack amaranth, simply pull them off by hand and destroy them. Sukuma wiki can suffer from Diamond Back Moth (DBM), aphids and powdery mildew.

DBM adult (right) and DBM pupae on leaf (left)

Diamond back moth caterpillars feed on leaves, causing holes in the leaf. They leave small black droppings (frass) on the leaf, which will help identify the problem as caterpillar damage. (left)

Cabbage aphid (left) powdery mildew (right)

A 15 L knapsack is enough to spray from 20 to 40 bag gardens (depending on the size of the plants).

Ensure all sides of the bag and all plants in the bag by walking around the bag when spraying. If the bags are organized in a line – walk up one side and spray; then walk up the other side and spray

Uwezo

Syngenta make a series of good quality, reliable pesticides in pack sizes suitable for small-scale farmers – the series is called UWEZO. Uwezo is stocked by most agrovets. The pack sizes are sufficient to use in one 15 litre spray tank.

Check the Labels and use the product specific to the pest present. Do not spray if the pest levels are not high. Observe all health and safety instruction and leave the recommended number of days after spraying – before picking any produce

Organic solutions

Hand pick of the pests and remove diseased leaves as they appear.

Use soapy water or high pressure water sprays to wash the pests off the plant.

Remember NOT to spray plants during hot weather to avoid scorching leaves.

Pumpkin growing systems

Pumpkins grown in bags

Pumpkins can be grown in bags and allowed either to grow up and over a fence, or ramble over less fertile or rocky ground. Old maize stalks can also be used as a 'fence' or trellis for pumpkins, after the maize has been harvested.

This allows them to be irrigated in the bag more easily, since the bag (where the root system is) can be more easily found and watered; or additional fertiliser applied.

The 'bag system' for pumpkins is different from the bags used for sukuma wiki and amaranth, described above. These bags are simply bags, half-filled with good quality compost and the top edge is rolled down to make a shorter bag. Pumpkin seeds or transplants are planted into the open top of the bag – not into the side of the bags as described above for sukuma wiki.

This type of bag system is also useful for tomatoes in greenhouses or Irish potatoes outside, where the soil is contaminated with bacterial wilt.

Pumpkins grown in the soil

If planted in the soil, pumpkins require fertile soil with a lot of organic matter. Good quality seeds (large and clean) can be either planted directly at 2.5 cm depth, or transplants can be made and the young plants (10 cm high at about 4 weeks old) can be transplanted at 2 meters between plants and 2 meters between rows.

If water-logging is likely to be a problem, this will cause root and fruit rots due to *Verticillium, Fusarium* or *Alternaria*. All of these are soil borne fungi – and is the reason why it may be helpful to grow the crop in a bag and train the pumpkins to grow over a fence. An alternative is to make a ridge or dome of soil and plant the pumpkin on the top. This increases the drainage and reduces the risk of soil diseases. This is more important in black cotton soil or plantings during the rainy seasons.

Pumpkin fruits which lie on the ground are likely to be infected with some soil borne diseases and may rot. The risk of rots is reduced if the fruit is lifted gently and placed on a mulch to keep it out of direct contact with the soil, whilst it ripens.

Irrigation

Good irrigation, during the fruit development period is important. The water needs to be applied where the plants roots are. It may be difficult to find the plants initial starting place (and its roots) once it has rambled over a large area.. Walking over vines to get to the root system to water it, may also cause physical damage to the stems that feed the pumpkins.

Drip Irrigation will assist with this problem and is best used if the pumpkins are grown in a bed system at two meter intervals.

Fertiliser

Take care to provide a balanced fertiliser, without too much nitrogen – otherwise the plants will produce too many leaves and not enough fruits.

Add 5 grams of DAP per plant in the planting holes (one teaspoon full only). Place the fertiliser immediately below the planting position and mix well into the soil, before planting the pumpkin transplant or seeds.

Four weeks later, top dress with 5 grams of CAN per plant on the soil surface, mix into the top layer of soil and water well.

When the pumpkin is setting fruit it will benefit from higher levels of potassium which is high in vermi-liquid fertiliser.

A simple 'fertigation' system can be made by burying an empty plastic bottle (with holes drilled into the base) about 6 inches away from the plant. Fill this once per week with one litre of vermi-liquid fertiliser made from 100 ml of pure vermi-liquid mixed with 900 ml of water. (see above)

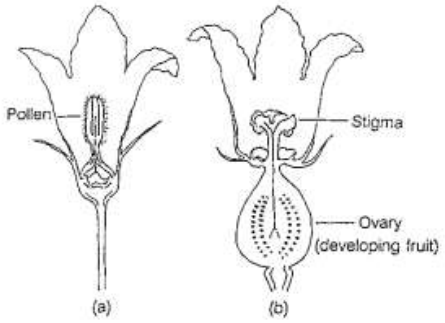
Blossom end rot

Blossom end rot is caused by irregular watering and an acidic soil. Overuse of DAP fertiliser can cause acidification of soils. Pumpkins need a pH of to avoid blossom end rot. Ensure regular watering during fruit swelling

Pollination

Pumpkins have both male and female flowers. The pollen needs to be transferred from the male anther to the female stigma, either by a bee or by hand.

Fig: Female flower (left) and male flower (right)



Female flower (right) and male flower (left)

The first flowers formed on a vine are male flowers and will not turn into pumpkins. There are usually ten male flowers to one female flower. Female flowers will fall off within a day if not pollinated. They tend to open up (ready for pollination) from 10.00 am to 3.00 pm. This is the best time to hand pollinate

Bee – covered in pumpkin pollen (opposite)

Bees need to visit the flower about 15 times during this period to get effective pollination if a large, uniform fruit is to develop properly. More seeds are also produced in s fruit which has been properly pollinated. Since seeds are also highly nutritious, the more seeds, the better.

However, the bee hives need to be closer than 1.5 kilometres to be interested enough in pumpkin pollen, without being distracted by other sources of pollen.

Hand Pollination is easy and ensures the optimum pollination occurs.

Step 1

Identify a mature male flower with plenty of ripe pollen on the anthers. Cut off the male flower and strip off any petals, to expose the anthers (opposite)

Step 2:

Use the prepared male flower like a paint brush and gently brush the stigma of the female flower with the male pollen (opposite)

Pollinated flower developing into a fruit (opposite)

Harvesting

Pumpkins are ripe from 13 to 17 weeks after planting and harvest will take place over a short period of 3 weeks. After this time the crop should be pulled out. An old, unproductive vine is a source of pests and diseases and should be composted, as soon as harvest is over. Leaves and flowers can be eaten.

Allow the pumpkins to ripen fully and develop a hard skin on the vine before picking them. The skin should be hard and if the pumpkin is gently wrapped with the knuckles, there should be a hollow sound. Wait for the vine to begin dying back if you can.

Do not harvest or handle wet fruit, as this may cause slight damage and will reduce the storability of the fruit. Harvest fruit very carefully to avoid damage as they will last longer in store.

Leave a long piece of stem attached to each pumpkin when you pick them. Don't carry pumpkins by the stalk, and handle them carefully to avoid cuts and bruises. If the stalk is damaged or falls off, seal the attachment point by melting candle wax into it.

Leave the pumpkins in full sun for a couple of weeks before bringing them in for storage (cover or move them if it looks like rain). This will toughen the skin and improve their shelf life.

Pick all leaves and remove the old vines to put on the compost heap or feed to animals. Do not leave immature fruit on the farm – compost it – as it will only be a source of pumpkin pests and diseases, if left to rot.

Yield

A single pumpkin will produce a lot of flowers, but should only be expected to produce about 2 fruit per vine – each weighing approximately 2- 4 kg each.

Serving sizes per person

A serving size of fresh pumpkin per person is up to 100 grams. It can also be made into pumpkin flour and mixed with other flours to make bread or even into maize flour for a vitamin A-enriched ugali. Pumpkin flour can replace up to 30% of other flours in a bread recipe.

Pumpkin bread is a rich golden colour and is sweet tasting. (opposite)

Total amount of bread flour per medium-sized loaf of bread is 500 grams which can be shared with 5 people. So the total flour needed per person is 100 grams. If 30% is replaced with pumpkin (or carrot) flour the amount needed is about 35 grams of pumpkin flour per person, per day (when it is on the menu).

Planting programme

Try not to keep an individual plant 'going' for more than 20 weeks. Instead have a planting programme which ensures a continuous supply of good quality fruit from vigorous vines.

Since the first fruits are not present for at least 13 weeks after planting and the harvest period should be limited to about 4 week - the new plantings should be staggered to ensure a more continuous harvest. The plantings should be every 4 weeks.

Each plant can be expected to produce about 6 kilos (2 fruit of 3kg).

The number of pumpkins to be planted depends on the number of people to be fed and the number of servings per week that need to be provided. It also depends on whether the output is for flour or for fresh vegetables.

Calculations for fresh pumpkin production

- If the farm must feed 100 people with100 grams of pumpkin per person, twice per week - this requires 20 kilos of pumpkin per week.
- Each pumpkin plant can produce a total of 6 kilos of fresh pumpkin flesh, so the farm must be able to harvest from at least 4 plants each week (20 kilos ÷ 6 kilos = about 4 plants)
- However, the total harvest per plant of 6 kilos takes place over, not one week, but a 4 week period, so the total number of plants needed would be four times higher. Therefore 16 plants would be needed.
- For the above pumpkin production requirement: plant either 16 new pumpkin plants every 4 weeks; or 4 pumpkin plants per week.

Calculations for pumpkin production for pumpkin flour

- Fresh pumpkin is about 90% water. After dehydration about 85% of the water will be taken out of the fresh pumpkin. New pumpkin flour probably still contains 14% water.

- So for every 100 grams of fresh pumpkin, 90 grams is water. Dehydration will take out 85% of the 90 grams of water – leaving a dry weight of 13.5 grams which can be made into 13.5 grams of pumpkin flour. Therefore for every 100 grams of pumpkin flour, the grower must produce 740 grams of fresh pumpkin (100 grams of pumpkin flour ÷ 13.5 grams = 7.4 (x 100 grams fresh pumpkin = 740 grams of fresh pumpkin needed for every 100 grams of flour)

- If the farm must feed 100 people with 35 grams of pumpkin flour per person, twice per week - this requires 7 kilos s of pumpkin flour per week.

- For one kilo of pumpkin flour, the grower needs to grow 7.4 kilos of fresh pumpkin. For 7 kilos of pumpkin flour, the grower needs to produce about 52 kilos of pumpkins.

- If the average weight of a pumpkin is 3 kilos; this requires about 18 pumpkins per week. One pumpkin plant produces about two large pumpkins – so 9 pumpkin plants need to be harvested per week.

- However, the total harvest per plant of 6 kilos takes place over, not one week, but a 4 week period, so the total number of plants needed would be four times higher. Therefore 36 plants would be needed.

- For the above pumpkin production requirement: plant either 36 new pumpkin plants every 4 weeks; or 9 pumpkin plants per week.

- Allow 2 meter square of ground for each pumpkin plant. This means a minimum of (36plants x 2 m sq) 72 meter square would be needed per month. Since the crop is in the ground for at least 5 months, there would be five plantings of 72 meter square allocated to pumpkins on the farm (5 x 72 = 360 meter square).

- Growing the pumpkins on a fence would take up less space than growing the crop in the soil.

Storage

Before storing your pumpkins, wipe their skin down with a soft cloth soaked in vegetable oil. This will remove any dirt which may have fungi in it that will cause rots in storage, and the thin layer of oil will help prevent moisture getting into the skin. If the pumpkins are to be stored for many months, repeat this wipe-down occasionally.

The best storage place is somewhere cool, dark, dry and well-ventilated. The ideal storage temperature is around 12 ˚ C.

Pumpkins should be lifted off the ground to improve airflow around them, and should not be touching each other. Place them on newspaper or straw, on top of chicken wire or timber slats. Store them on their side, so that moisture doesn't accumulate in the hollow around the stem.

Don't store pumpkins with tomatoes, pineapples or other ripening fruit. The ethylene gas the fruit gives off will hasten the deterioration of your pumpkins.

Do not permit harvested or stored fruit to get wet.

Washing is usually not desirable, but if washing is necessary, be sure the water is chlorinated (at least 50 ppm, approximately one part 5.25% liquid bleach to 999 parts water). Prepare fresh wash solution when the water becomes cloudy and chlorine cannot be detected. Dry thoroughly

Check your stored pumpkins regularly. Remove (eat or discard) any that start to soften or rot, or have become damaged.

Over time, your stored pumpkins will get lighter as they lose moisture content. That's not a bad thing though – they become sweeter and more richly-flavoured the longer they're stored.

Storage life is typically 2 to 3 months without significant loss in quality, if all the above care is taken.

Husbandry tips

- The tips of the pumpkin vine can be cut off to stop the plant from rambling over too big an area and to concentrate the energy of the plant into producing better quality fruit. Try to contain the plant in a 2 meter square area per plant.
- To encourage fruit to set, the grower can manually pollinate the flower by taking the male anther with pollen and brushing it on the female stigma
- If fruit fly is a problem, the fruit can be protected with a paper bag to stop the fruit fly laying its egg in the young fruit.
- The fruit may rot when in contact with moist soil, so often cut grass or leaves are placed beneath the fruit.

Pumpkin disease control

The most common disease is **powdery mildew** which can seriously damage the ability of the leaves to feed the fruit. (see below)

Crops grown on fences are more easily sprayed for mildew control. Powdery mildew is more common when there are periods of warm weather with occasional rain.

A spray programme with sulphur or *Bacillus subtilis* can be used by organic growers for this disease; whilst other growers can also incorporate Ortiva (azoxystrobin) – at the rates advised above.

Soil diseases and fruit rots of various types are reduced by:

- Good rotation (if grown in the soil)
- Avoid over-crowding – cut back the tips of vines once they grow outside their allotted 2 meter square. This improves ventilation around the leaves and fruit.
- Provide even and adequate irrigation to avoid plant stress and blossom end rot
- Avoid water splash onto fruits and leaves when watering the plant (this can spread the disease)

- Do not step on vines and crush the stems, when applying water, fertiliser or sprays to the crop.
- Remove and destroy diseased fruits to prevent spread of a disease.
- Do not over apply nitrogen fertilisers

It is not uncommon for some flowers to abort soon after opening, as 90% are only male flowers. Poor pollination can also lead to abortion of small fruits. Fruit abortion can also occur if there are too many fruit on the vine.

Pumpkin pest control

Pumpkins suffer from attack by **fruit flies**, which lay eggs in the soft flesh of young fruits. Maggots develop inside the fruit, destroying the fruit.
(see lifecycle diagram below)

Fruit flies can be caught in home-made traps made out of a plastic water bottle with a cup of dilute (10%) vinegar. Make 6 small holes around the side of the bottle at the top, so that fruit flies, attracted to the smell of the vinegar can enter the bottle. Do not make them too big, so that it is easy for the flies to get out as well. (see below)

Ref: www.infonet-biovision.org

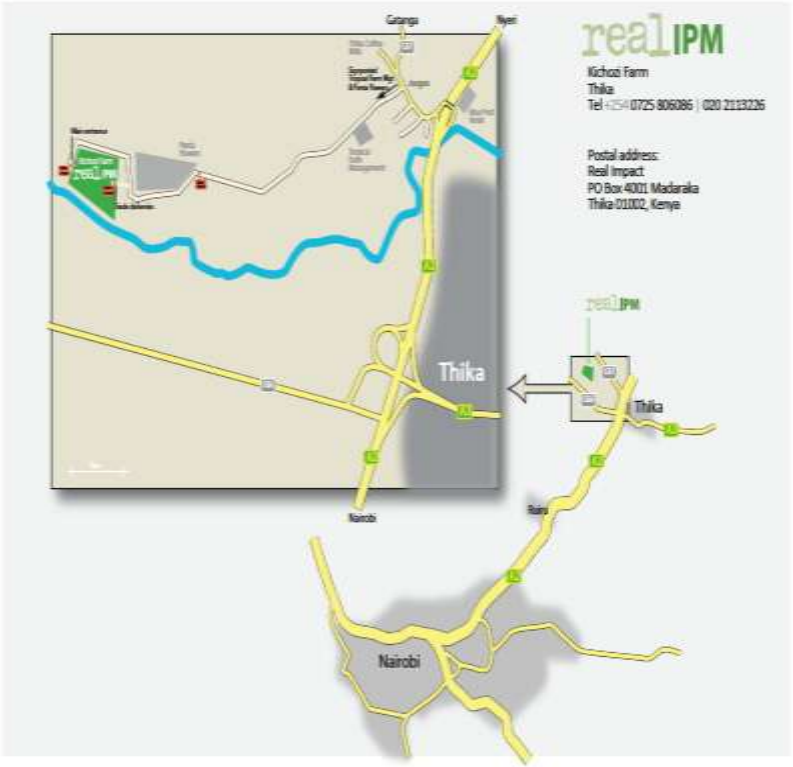
Hang the trap in a nearby tree in the shade. Leave the dead fruit flies in the vinegar, as they also help to attract more fruit flies, by the pheromones they give off.

Young fruits can be protected by gently securing a paper bag (not a plstic bag) around the fruit, when it is very young.

Following the guidelines for caterpillar and aphid control in sukuma and amaranth (see above section) will provide some control of fruit fly.

Pumpkins leaves are also attached by **leaf miner** flies, but rarely need spraying for this pest as the parasitic wasp, Diglyphus, should be present naturally and kill the leafminer larvae tunnelling in the leaf.

The adult leafminer (bottom left) lays eggs in the leaf. The larvae feed inside the leaf making 'tunnels' in the leaf (opposite left). The parasitic wasp, Diglyphus lays eggs in the leafminer larvae, when it is still in the leaf (below right).



Real Impact Farm Walks

Groups of up to 20 people are welcome by appointment only and a fee of 6,000/- for the group will be paid for a two hour farm walk with explanations of techniques used.
For more information please contact:

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