GRAIN AMARANTH TRAINING MANUAL

Grain amaranth production technologies for enhanced food and nutritional security

Grain Amaranth Production Technologies For Enhanced Food And Nutritional Security

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A high percentage of the population in the arid and semi-arid lands is faced with chronic malnutrition and vitamin deficiency due to persistent food shortages and low nutrients in the diet. Grain amaranth (*A. hypodriacus* L.) is highly nutritious and therefore ideal for food and nutrition security in these areas. Amaranth grain contains protein (16-20%), oil (5-10%) phosphorus, magnesium, calcium, iron and zinc, vitamins B, C and E and dietary fibre. It is rich in the essential amino acid lysine required by the body for calcium absorption and promotion of bone growth and which is low in cereals like maize, rice and wheat. The crop is relatively tolerant to drought and can withstand low rainfall conditions especially under conditions of climate change. Amaranth production in semi-arid eastern Kenya is however, at its infancy with limited information on production technologies for the low soil moisture and fertility conditions in the region.

Currently demand outstrips supply in the country with most of the processors importing the grain thus making it a competitive source of household income generation. Amaranth can grow in a wide range of environmental conditions between 0-2400 meters above sea level (a.s.l). Production of grain amaranth is steadily picking up in the ASALs of eastern Kenya due to awareness created by Kenya Agricultural and Livestock Research Organization (KALRO) Katumani. Despite this increased interest recommended agronomic packages for its production in pure or mixed stands are lacking. This manual is meant to bridge the void of information in the cultivation of grain Amranth in Kenya.

The technical contents of this publication draw on many separate studies and experiences in Kenya. The manual is an output from Arid and Semi-Arid Lands Agricultural Productivity Research Project (ASAL...
APRP) funded by the European Union (EU) and Government of Kenya and implemented by KALRO. It is my hope that the manual will not only benefit farmers but all those interested and engaged in the development of Grain amaranth as a food and nutritional security crop in Kenya.

_Eliud Kireger (PhD)_
_Director General_
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1.0 **Introduction**

Scientific name: *Amaranthus spp.*
Common name: Pigweed
Kiswahili: Muchicha

Amaranthus is a herbaceous, annual upright and fast growing plant in the *Amaranthaceae* family. It consists of about 60-70 different species spread all over the world in temperate, sub-tropical and tropical climates. These species consist of grain, vegetable, ornamental and weedy types. Amaranth is slightly branched from the main stem. The stem is fleshy, stalky and sometimes grooved, green or purple in colour or a mixture of the two shades. Leaves are alternate, simple and entire. Leaves of difference species of amaranth show a lot of variability in form, shape, size and colour. Generally leaves are green or red or a mixture of the two shades while some are purple.

Vegetable amaranth include *A. dubius* and *A. tricolor* among others and produce inflorescence along the stem. Their seeds are shiny, black and smaller in size compared to those of grain types. Amaranthus *caudutus* is grown for ornamental, grain production and dye extraction. It has showy inflorescence ranging in colour from pale green to red, pink and purple. The grain types include *A. hypochondrius* and *A. creuntus*. Grain types produce a loose panicle borne on the plant apex. They have pale coloured seeds ranging from whitish cream, tan and golden to deep pink. All amaranths, however, produce very nutritious edible leaves.
1.1 Grain amaranth attributes

Grain amaranth (*A. hypochondriacus* and *A. cruentus*), pseudo-cereal, is a native to South America and a relative of the local amaranths (*Amaranthus spp*). It has multiple uses as a vegetable, nutrient rich grains and livestock feed. It is early maturing (75-90 days), relatively drought tolerant and gives reasonable yields even under low soil fertility and rainfall conditions. Leaves are ready for eating as an early vegetable in the season at three weeks after planting.

Grain amaranth is highly nutritious and contains protein (16-20%), oil (5-10%), phosphorus, calcium, zinc, vitamins B, C and E and dietary fibre. It has two times the amount of calcium found in milk. It is particularly rich in the amino acid lysine which is low in cereals like maize and wheat. Cooked grain is up to 90% digestible and an excellent weaning diet, recommended for the elderly and people who have been through a long fast or starvation. Being an immune booster it is good for people with compromised immunity, the elderly and those that are severely malnourished. The grains are glutenin free and therefore good for people who cannot tolerate this substance. Cooked grain is up to 90% digestible making it an excellent weaning diet. Nutritive values of cereals are enriched when blended with amaranth. Some 45% of the population suffers chronic malnutrition with about 35% of women and children subjected to hidden hunger. The crop is therefore ideal for improving food security and nutritional status of the vulnerable groups particularly in hot dry areas of Kenya.
Amaranth leaves are high in vitamins A, K, B6, C, riboflavin and folate; and essential minerals including calcium, iron, magnesium, phosphorus, potassium, zinc, copper, and manganese. The vegetables are very rich in iron and therefore good for anaemic people. They are high in vitamin A and one hundred (100) grams of vegetables cooked without oil can contribute up to 45% of the daily vitamin A requirement.

Amaranth can grow in a wide range of environmental conditions between 0-2400 meters above sea level (a.s.l). It is a warm climate plant and thrives well between 22-350C under plenty of sunshine. Amaranth is relatively drought tolerant and can give reasonable yields. The crop’s ability to withstand moisture stress is not well understood but amaranth growth ceases in adverse weather until conditions are favourable. It can however be grown all year round under irrigation. The crop thrives well in deep well drained soils with high organic matter content. Shallow, stony, crusty clay soils with waterlogging logging properties should be avoided.

Areas of production in Kenya
- Western Kenya
- Coastal region
- Rift valley
- Eastern Kenya (after being introduced by KALRO Katumani).

1.2 Grain Amaranth varieties commonly grown in Kenya
1.2.1 Katumani amaranth (KAM) 114
- The plant is bushy, growing to about 2 meters high
- The stem is green with a light purplish base
- It has broad green leaves
- The plant bears several panicles on each branch
- The panicle is open, green in colour and turns to yellowish green and then light golden when mature
- It is very small seeded (1000 seeds weigh about 0.6-1.2 grams)
- The seeds are golden in colour
• Yield potential in the ASALs is 550 kg grain and 400 kg leaves per acre

1.2.2 Katumani amaranth (KAM) 001
• The plant is erect growing to about 2 meters high,
• The stem is green with a light purplish base
• It has very broad green leaves
• The plant bears one panicle at the apex and few small panicles on branches
• The panicle is open, green in colour sometimes with a pink hue and turns to yellowish green and then light golden when mature
• It is very small seeded (1000 seeds weigh about 0.6-1.2 grams)
• The seeds are creamish white and lenticular in shape
• Yield potential in the ASALs is 500 kg grain of grain and 300 kg leaves per acre
1.2.3 Katumani amaranth (KAM) 201

- As KAM 114 but the seeds are reddish brown in colour
- Yield potential in the ASALs is 550 kg grain and 400 kg leaves per hectare

1.3 Amaranth uses

Amaranth vegetables are used in salads, sauces and stews while the stem and older leaves can be used as livestock feed. The whole grains are boiled, roasted or popped or eaten as sprouts. The grain may milled into flour, blended with wheat flour to enable it to rise and used in the baking and confectionery industry. Amaranth and wheat flours blended at different ratios can be used to make chapatti (flat bread), mandazi, doughnuts, cakes and pancakes at home. Amaranth flour can be blended with maize or sorghum flour to make ‘ugali ’ or porridge. Pure amaranth flour can be used to make amaranth porridge. The grain contain oils that is extracted for industrial applications.
2.0 Agronomic requirements

2.1 Land preparation

Grain amaranth is a very small seeded crop and therefore requires a fine seedbed. For virgin land, oxen or tractor ploughing followed by harrowing is recommended. For cultivated land harrowing is necessary.

After harrowing soil clods should be broken and the field levelled to suit the size of the seeds.
2.2 Planting and Seed Rate

Planting should be done at the onset of the rains. Make shallow furrows spaced at 75-90 cm apart. Amaranth may also be planted under irrigation. Amaranth does well in fertile soils with high organic matter content. Apply well decomposed farm yard manure (FYM) at the rate of 10 tons per hectare. Thoroughly mix the FYM with soil using a stick. Alternatively DAP can be applied at a rate of 50 kg (1 bag) per hectare. Fertilizer application has been found to be useful during the short rains season (October-December) when the rainfall is evenly distributed or under irrigation. Compost manure can also be used at rate of 10-12 tons per hectare.

A seed rate of about 1 kg per acre is recommended. Mix grain amaranth seeds with dry sand or soil at the ratio of 1: 10-15 (1 part seed to 10-15 parts sand or soil) to avoid wastage and for even drilling of seeds.
Drill the seed mixture evenly and thinly in the already prepared furrows at a depth of 5 cm. The seed-soil mixture can also be planted along the rows at a spacing of 30 cm apart.

Cover the seed lightly with soil using a stick. The seeds possess an aroma that attracts ants and therefore should be covered immediately after sowing to avoid being carried away by ants. Amaranth requires adequate moist conditions for establishment. When there is adequate moisture in the soil, seeds germinate 3-4 days after sowing. Once the crop is established it is relatively drought tolerant.

Amaranth is a cross pollinated crop and hybridization occurs between species. When planting amaranth for production of seeds an isolation distance of 400 meters should be maintained to avoid seed contamination. Off types should be uprooted regularly
2.3 Weeding
Initially amaranth grows very slowly making it susceptible to competition from weeds. Weeding is crucial at this initial stage until the crop is well established. Keep the crop free from weeds by weeding with hoe, oxen or by uprooting. More than 90% of the crop can be lost due to weed competition in the early stages before proper plant establishment.

Weeding may be done 3-4 times during the growing season until the crop forms its own canopy and is able to smother weeds. Keep the field free of weeds by weeding or uprooting weeds.
Water harvesting structures such as ridges can be constructed at weeding to aid in moisture conservation during seasons when rainfall is below average. When the plants are about 30cm high earth up soil around plants to avoid lodging. This also helps reduces competition from weeds. This also helps reduces competition from weeds.

2.4 Thinning
First thinning should be done after the crop has attained a height of about 10cm. Uproot weak and malformed plants and leave the strong and robust ones. The first thinning is done to reduce the plant population and lower completion, encourage aeration and light penetration. Subsequent thinning should be done until the onset of heading, leaving one plant at an intra-row spacing of 30 cm apart. The thinned leaves can be used as vegetables or fed to livestock.
Well thinned amaranth crop
3.0 Protection of amaranth against insect pests and diseases

There are several insect pests that attack Amaranthus including leave miners, aphids, bollworms and sporadic insects like skeletonizers which attack the leaves. These pests mainly attack the foliage and the flower bud while the pigweed beetle damages the stem. The diseases reported for amaranth are leaf spots and dumping off plus isolated incidences of black mold on amaranth panicles in the ASALs.

3.1 Continuous surveillance against pest and diseases

There is need to regularly scout the amaranth field to make sure the plants continue to develop without any attack of pest and diseases. Most pests and disease occur at the flower bud stage. When the plants have attained six to ten leaves (approximately one month old) visit the field and scout for presence of windowing or mining symptoms on the leaves. These could be bollworms or leaf miners. These insects reduce the photosynthetic area of the leaf tissue, leading to reduced leaf or grain depending on the variety. Little disease symptoms occur at vegetative growth.
Note diseased panicle on the left: remove plant from the field and bury in soil

Tending to young amaranth

Windowed leaves

3.2 Insect pests
3.2.1 Pigweed beetle

The pigweed *Hypolixus haerens* Boheman lay its eggs on young plants at age of three weeks after emergency. It follows that application of systemic insecticide has to be applied within the first month of planting. The damage on the stem will only be clearly visible when the plant is mature. By the time the hole is open on the stem the back or brownish beetle will have left the plant searching for another suitable host plant to lay eggs on the stem. During dry spell the pigweed beetle burrows in the soil to wait for another rain season to start breeding again.

i. Pigweed beetle damage on stem

ii. Early spraying prevents damage
3.3 Control of insect pests
3.3.1 Control of pests at vegetative stage
A spray of Bulldock Star® 262.5 EC (Pyrethroid-organophosphate) or Beta-cyfluthrin 12.5g/litre twice at intervals of two weeks is crucial for elimination of leaf miners, leaf defoliators and pigweed beetle. Other emerging insecticides can also be assessed as need may arise.

3.3.2 Destroy plant residues after harvest
After harvesting of the grain it is important to burn the plant residues or feed them to livestock. This will ensure complete destruction of pest reservoir in the field before subsequent cropping seasons. The pigweed beetle “resting” in the plant debris will be destroyed together with the similar case of bollworm and leaf miners.

3.4 Diseases
3.4.1 Amaranth panicle black mold
Amaranth mold is a fungal disease caused by Aspergillus spp. It is a secondary infection that attacks the panicles (heads) when the crop is left in the field for too long after attaining physiological maturity.

3.4.2 Disease symptoms
Sooty (black) fungal mold covering the entire panicles.

3.5 Disease control
• Harvest infected panicles separately and destroy.
• Use clean seed.
4.0 Harvesting and seed processing

4.1 Harvesting of both leaves and grains
Both leaves and grain of amaranth are harvested.

4.1.1 Leaf harvesting
Leaf harvesting commences at three weeks after germination. Leaves should be harvested in the morning when weather is cool to avoid dehydration. Leaf harvesting should be done in moderation as overharvesting of leaves may have a negative effect on grain yield. Leaves aid in photosynthesis, if over harvested panicle developed will be affected and hence grain yield. Harvest by clipping tender leaves once a week until the onset of heading. Leaf harvesting should be done carefully to avoid injuries to the plant. Once the plant flowers, leaf harvesting should be stopped to encourage panicle development and grain filling. This is very critical and determines the grain yield. Over harvesting of leaves may result in reduction of grain yield by up to 70%. Besides, at the flowering stage leaf formation is significantly reduced and the few ones remaining tend to be fibrous and unfit for human consumption.
4.1.2 Grain harvesting

Grain amaranth shuts easily, it is therefore recommended that the crop is harvested as soon as the colour of the panicles/heads turns from green to golden and seed shade on light shaking of the plant. The crop should be harvested when the grain is opaque and not translucent. Percentage loss due to delayed harvesting may be up to 50% or more.

*Harvesting the dry panicles into a bucket (left) or gunny bag (right)*

Bend the heads and insert in a container without holes such a gunny bag or a bucket. Cut off the panicle so that it detaches from the stem and falls into the container. This ensures less seeds are lost during harvesting.

4.2 Grain processing

Place the panicles harvested on a clean polythene sheet or canvas to dry under the sun. Thresh the panicles by hitting lightly with a stick turn them regularly to ensure that all the seeds are released. The panicle may also be threshed using an amaranth thresher. Separate the waste from the grain. The waste maybe fed to livestock or used as mulch.

Winnow the grain using shallow basins, calabashes or trays to remove the chuff. Place the grain on a clean canvas or plastic sheeting, spread evenly and allow to dry in the sun. Turn grain frequently to ensure proper drying, the progress may take two to three days during hot dry weather. The correct moisture content for
storing grain amaranth is 11-13%. This can be determined by a moisture metre or the ‘salt test’.

The salt test

The following items are required:
- About 250-300 grams (1 standard cup/glass) of dried grain
- 2-3 tablespoons dry salt
- A bottle of 750 millilitres (ml) capacity with a tight fitting lid

To dry the salt place it on a large lid or polythene sheeting and dry it in the hot sun for 3-4 hours. Fill 1/3 of the bottle with dry amaranth grain, add the dried salt and close the bottle tightly. Shake the mixture thoroughly until the salt is evenly distributed in the grain. Allow to stand for 15 minutes. The grain is dry if there is no salt and grain particles sticking on the sides of the bottle.

(a) Wet grain (amaranth seeds and salt particles sticking to the sides of the bottle)
(b) Dry grain and salt at the base of the bottle
Impurities lower seed quality and encourage microbial growth. Ensure that seeds are not contaminated with sand or soil particles and plant debris right from harvesting through processing to storage. Put dried seed in gunny bags and store in a cool dry place. Properly dried and well stored seeds can keep for up to 2 years without deteriorating. Amaranth seeds may remain viable for up to 5 years at 5% moisture content.
5.0 Reference


