KENYA AGRICULTURAL AND LIVESTOCK RESEARCH ORGANIZATION

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FACTSHEET FOR TECHNOLOGY INNOVATORS WORKING WITH SMALL HOLDER FARMERS IN KENYA

MAIZE

INTRODUCTION

- Local names in Kenya (*Mahindi*, *Oduma*, *Bando*, *Madumwa*, *Bemba*, *Bembe*)
- Maize (*Zea mays* L.) is the most important cereal crop in Kenya with per capita consumption of 103 kg/ year.
- The crop can be used as food, feed for animals and as a source of industrial raw material.
- As food maize grain is an important source of carbohydrate, protein, iron, vitamin B, and minerals.
- Maize grain products include boiled, baked and roasted fresh maize on the cob, porridge (*uji*), fermented porridge, stiff porridge (*ugali*), beer, starch and oil
- The crop is grown both for subsistence and as a commercial crop by large-scale farmers (25%),and smallholders (75%)
- Total annual production is estimated at about 4.0 metric tons against a consumption of about 4.5 million metric tons.

SITE SELECTION

Select highly productive land with sufficient sunshine avoiding steep slopes, very sandy soils, areas prone to water-logging, couch grass and/or shady places, and should be at least 10 meters away from the road to prevent dust and vehicle fume.

Altitude range

Maize is grown at all altitudes ranging from 15 metres above sea level (masl) at the Coast to more than 2,000 masl of the highlands.

Rainfall

Optimum rainfall range is 500 to 1200 mm fairly distributed during the growing period. For higher yields, aim at enough rainfall during the first five weeks after sowing and at flowering time. Moisture stress at flowering time interferes with pollination and drastically lowers grain yields.

Soil type and conditions

On average maize requires deep, well drained, fertile alluvial or loam soils with good water holding capacity and high organic matter. Avoid water logged soils because if maize stands in water for more than two days it withers and dies off. Routinely analyze soils for nutrients. Optimum pH range is 5.5- 6.8. Maize nutrient requirements include; N, P, K, Mg, Ca, S, Fe, Zn, Mn, B, Cu, Mo, Cl.

Temperature

The optimum temperature for maize growth and development is 18 to 32 °C.

LAND PREPARATION

Proper maize land preparation is prerequisite for increased water infiltration, controlling weeds, pests and diseases and enhancement of O_2 and CO_2 circulation so as to optimize maize plant growth. There are three main Land preparation practices.

i) *Conventional tillage*:

Plough and harrow either using mould board plough, disc plough, sub soil plough, chisel and plough powered by tractor or draft animals like oxen or donkey. Through this the weeds and stubble are incorporated into the soil to add fertility.

ii) Minimum tillage:

Use of cutlass to slash weeds and vegetation regrowth on the farm with little manipulation with a hole or rake. Use the stubble as mulching material to conserve soil moisture. Decomposition of the weed and debris add nutrients to the soil.

iii) Zero tillage:

Open a narrow strip of 2-3cm wide or hole in the ground and insert the seed. Use of herbicides to kill the weeds and cutlass without disturbing the land. Plant the maize seed directly without tilling or ploughing the soil.

PLANTING

- Plant recommended varieties for your agro-ecological zone.
- Use certified seed from authorized Stockists.

Plant within the first two weeks of the onset of rains. The recommended spacing of pure stand are as follows:-

- Highland: 75x25cm 1 plant/hill and 75 x 50cm 2 plants/hill.
- Medium: 75 x 30cm 1 plant/hill and 75 x 60cm 2 plants/hill.
- Dry land and coastal 90 x 30cm 1 plant/hill and 90x 60cm 2 plants/hill.

Highland zones

- Altitude:1600-2900m asl
- Rainfall >1800 mm.

Recommended varieties

H614D

Attributes

- Grain yield of 30-35 bags per acre.
- Maturity duration 145 – 175 days.
- Resistance to grey leaf spot, rust, blight.
- Has good husk cover and strong stalks.
- White semi- flint kernels.

H600-11D

Attributes

- Grain yield 32 – 42 bags per acre.
- maturity duration 140-160 days.
- Resistance to grey leaf spot.
- Has good husk cover and strong stalks.
- white semi- flint kernels.

Other recommended varieties: H626, H625, H6213, H6218, H6210, H629, H628, H624, KH600-23A, High Altitude Composite (HAC), KH600-14E KH600-15A KH600-16A, KH600-17A, KH600-18A, KH600-19A, KH600-20A, KH600-21A, KH600-22A, KH600-23A, KH600-25A, KH600-26A, KH600-27A.

Medium altitude - transitional

- Altitude: 1200-2000 masl
- Rainfall 1000 to 1800 mm.

Recommended varieties

WE5113

Attributes

- Grain yield of 3.7 to 7.3 t/ha.
- Maturity duration of 105 to 130 days.
- Tolerant to drought.

- Resistant to major maize leaf diseases such as northern leaf blight, gray leaf spot and maize streak virus.
- Has good husk cover, plant and ear aspects.

WE5107


Attributes

- Grain yield of 3.7 to 7.2 t/ha.
- Maturity duration of 105 to 130 days.
- Tolerant to drought.
- Resistant to major maize leaf diseases such as northern leaf blight, gray leaf spot and maize streak virus.
- Has good husk cover, plant and ear aspects.

Other recommended varieties: KH500-51A, KH500-52A, KH500-53A, KH500-55A, KH500-54A, KH500-56A, Special Kit – MLN: KATEH14-05, KATEH14-03, KH125-01-SG.

Medium altitude – Moist

- Altitude: 1100-1500 masl
- Rainfall 800 to 1200 mm

Recommended varieties

KH500-56A (KM1101)

Attributes

- Grain yield of 6.5 t/ha.
- Maturity duration of 5 to 6 months.
- A white cob flint to intermediate like.

- Resistant to maize streak virus and gray leaf spot.
- Has good husk cover and ear aspects.

WE2101

Attributes

- Grain yield of 6.9 t/ha.
- Maturity duration of 4.5 months.
- Resistant to leaf diseases such as northern leaf blight, gray leaf spot and maize streak virus.
- Has good husk cover and good plant and ear aspect.

Other recommended varieties: EMB225, EMB226, KH500-13E, KH500-40E, KH500-39E, KH500-Q.

Medium Altitude - dry

- Altitude: 700 -1700m asl
- Rainfall 400 - 800 mm.

Recommended varieties

KDH414-11 (Ukamez 6)

Attributes

- Grain yield of 4.6 - 7.5 t/ha.
- Maturity duration 90 – 100 days.
- Tolerant to drought.
- Resistant to major leaf diseases such as gray leaf spot, northern leaf blight and maize streak virus.

KDH414-12 (Ukamez 7)

Attributes

- Grain yield of 4.3 - 7.8 t/ha
- Maturity duration 90-100 days
- A stay green
- Tolerant drought
- Resistant to major leaf diseases such as gray leaf spot, northern leaf blight and maize streak virus

Other recommended varieties: KCB (Katumani Composite B), KDH6 SBR, KDH414-03 SBR, KH125-03 SG Katumani, KH125-03 MDR, KDH414-05 (1), KATEH14-03, DSLH103 – SAWA, DH04, WE2101, WE2104, WE2106, WE2107, WE2108, WE2109, WE2110, WE2111, WE3104, WE3106.

Coastal Lowlands

- Altitude: < 700m asl
- Rainfall 400 - 1400 mm.

Recommended varieties

Shukran-16(CKH08069)

Attributes

- Grain yield potential of 25 – 30 bags per acre.
- Average maturity duration of 120 days.
- Tolerant to drought and foliar diseases.

Other recommended varieties:WSQ104 (OPV), KH500Q, PH1, MTPEH0701, MTPEH0702, MTPEH0703, WE2111.

SOIL FERTILITY REQUIREMENTS AND MANAGEMENT

- Manage soil fertility through organic fertilizers/manures, and/or inorganic or chemical fertilizer.
- First consideration is application of manure for it enhances soil fertility and soil health that leads to increased yields, improved soil structure and biodiversity.
- Inorganic fertilizers, nitrogen (N) and phosphorous (P) are the two most important nutrients for maize, but maize also requires potassium and, on some soils, Zinc in small quantities.
- Apply basal fertilizer before or at the time of planting. Apply the fertilizer in the planting holes then mix with soil to protect the seed from scotching, plant and cover the seed or apply in a band below and to the side of the seed with a mechanical planter.
- Apply zinc enriched basal fertilizers every two to three years on sandy soils.
- Apply top dressing fertilizer when the maize is at 3.5 to 6 Weeks. A maximum of three top dressing splits are recommended in sandy to sandy loam soils. Apply around the crop avoiding direct contact to protect the crop from scotching.
- Add agricultural lime to acidic soils to improve response to fertilizers
- Reduce fertilizer rates under drought conditions, where manure is applied or when the maize is following a legume
- Maize grain yield potential largely depends on the variety, expected rainfall and on the management applied to the crop.
- General recommendation for fertilizing maize with inorganic fertilizers are shown in table 1:

Table 1: Recommended N & P nutrient fertilizer application at a given

Fertilizer type	Yield potential		
	< 3 t/ha	3 to 5 t/ha	5 to 8 t/ha
	Number of 50 kg bags of fertilizer		
Basal fertilizer	0 to 3 bags/ha	2 to 5 bags/ha	5 to 7 bags/ha
	0 to 150 kg/ha	100 to 250 kg/ha	250 to 350 kg/ha
Top dressing	1 to 3 bags/ha	2 to 5 bags/ha	6 to 10 bags/ha
Nutrient rate	0 to 150 kg/ha	100 to 250 kg/ha	300 to 500 kg/ha
P	10 to 30 kg/ha	30 to 50 kg/ha	50 to 80 kg/ha
N	30 to 60 kg/ha	60 to 100 kg/ha	100 - 160kg/ha

ROUTINE CROP MANAGEMENT

Weeding

The first four to six weeks after emergence is the most critical stage of weed competition in the life of a maize plant.

- **Hand weeding**: At least three weeks after emergence of the plants followed by a second weeding at knee high.
- **Herbicides**: Apply before or immediately after planting for post-emergence herbicides.
- **Striga control:** managed using clean seeds and equipment, push and pull, use of resistant varieties or apply *kichawi* - kill in the hole at planting.
- Check for pests and diseases.

SOIL AND WATER CONSERVATION

- Conservation of soil and water resources is important for sustainability of maize yields and environment.
- Practice soil and water conservation through

i) Conservation agriculture

Targets to conserve the soil, soil moisture, and soil-nutrients, and stabilise land production while reducing production costs.

Principles of conservation agriculture are :

1. Minimal soil disturbance
2. Permanent ground cover - maintenance of a mulch of carbon-rich organic matter covering and feeding the soil (e.g. straw and/or other crop residues including cover crops),
3. Crop rotation or sequences and associations of crops including trees, which could include nitrogen-fixing legumes.

ii) Insitu water harvesting

Bench terraces

Fanya Juu

Grass terraces

Zaipits

Furrow irrigation

Furrow irrigation system

In drought prone areas supplement water with surface irrigation.

- Dig trenches or "furrows" between crop rows in a field.

- Direct flow of water down the furrows (often using only the force of gravity), for the water to seep vertically and horizontally to refill the soil reservoir.


DISEASE AND PEST MANAGEMENT

Pests

Fall armyworm (*Spodoptera frugiperda)*


Prevention

- Plant clean seeds of resistant maize varieties preferably with hard husk cover to prevent the pest from penetrating.
- Plant early to avoid the build-up of pest population.
- Regularly remove weeds as they serve as alternative hosts and harbour the pest season after season.
- Practice crop rotation for a period of at least 6-8 weeks.
- Avoid planting young crop next to an older crop.
- Ensure optimum use of fertilizer for strong maize plants able to compensate for damage done.
- Avoid moving infested maize materials from one area to another; feed to livestock.

Control

- Hand pick larvae and crush them.
- Put a half handful of sand or sawdust or soil in the whorl of the plant.
- Plough deep to expose the pupae to predators and solar heat.
- Intercrop with chillies to repel adult moths.
- Release egg parasitoid *Trichogramma spp*.

- Use pheromone traps.
- Spray insecticides as they are most effective on young larvae and before they enter the funnel and ears.
- Spray neem based products e.g Nimbecidine, Neemroc 0.03% and Achook 0.15%.
- Spray Indoxacarb (Avaunt 150 SL) or Alpha-Cypermethrin (Bestox 100Ec or Tata alpha 10EC or Chlorantraniliprole (Corrgen) and Spinosad Tracer.
- Spray *Bacillus thuringiensis* (BT) based sprays e.g Baciguard 16 WDG, Bio-T-Plus, Biokill WP.

Maize stem borer

Chilo partellus, *Chilo orichaociliellus*, *Busseola fusca*, *Eldana saccharina*, and *Sesamia calamistis.*

Prevention

- Do early land preparation during dry season to expose the pupa to heat and predators and plant early in rainy periods
- Plant clean seeds of resistant maize varieties preferably with hard husk cover to prevent the pest from penetrating.
- Practice crop rotation especially with root crops or legumes
- Avoid alternate hosts such as sorghum and pearl millet.
- Use push-pull strategy: Intercrop maize with desmodium, a forage legume, and plat napier grass as a border crop. Desmodium repels stem borer moths while Napier grass attracts them. Desmodium can be replaced with clitoria while bracharia grass can replace napier grass in drought prone areas.
- After harvest, destroy crop residues to kill larvae and pupae in stems or chop the stovers and feed to livestock, make silage or incorporate into the soil. This will kill the pupae in the old stems to reduce more population the following season.

Control

- Put handful of soil or one bottle cap of ash dust into leaf funnel of infested plants to suffocate the larvae.
- Apply a pinch per plant of ground neem powder onto the funnel of young plants.
- Mix hot pepper + ash at a rate 50gm/2kg ash and put a pinch per funnel onto knee-high young plants.
- Spray insecticides as they are most effective on young larvae and before they enter the funnel and ears.
    - Spray neem based products e.g Nimbecidine, Neemroc 0.03% and Achook 0.15%,

- Spray with Deltamethrin based products such as Farm-X, Atom 2.5EC, and Decis 2.5EC at 1015mls/20L of water
- Spray *Bacillus thuringiensis* (BT) based sprays e.g Baciguard 16 WDG, Bio-T-Plus, Biokill WP,

Important Diseases:

Viruses

Maize Lethal Necrosis disease (MLND)

- **Causal agent**: Caused by synergestic co-infection of *maize chlorotic mottle virus* (MCMV) and *maize dwarf mosaic virus* (MDMV) or *wheat streak mosaic virus* (WSMV) or *sugarcane mosaic virus* (SCMV).

Symptoms

- Chlorotic mottling of the leaves, starting from the base of the young leaves in the whorl and extending upwards toward the leaf tips.
- Leaf necrosis at the leaf margins that progress to the mid-rib resulting in drying of the whole leaf.
- Dead hearts.
- shortened male inflorescences with few spikes, and/or shortened, malformed, partially filled ears
- Premature plant death

Prevention

- Plant certified seeds dressed with insecticides or certified seed of resistant varieties; do not recycle seed.
- Plant maize only during the long season.
- Avoid continuous maize mono crop to stop the persistence of virus and possible vectors.
- Practice strict crop rotation for at least 2 seasons with non-cereal crops like beans, garlic, chives, onions and vegetables
- Avoid moving plants from infected regions to non infected regions to reduce spread of disease
- Plant early with fertilizer and manure to enhance crop nutrition and vigour.
- Keep the field free from weeds which may be alternate hosts to the vector.

Control

- Uproot and destroy diseased plants by burning or burying 2 m deep to avoid mycotoxin contamination.
- Use the maize stalks to make the silage
- Use bio-pesticides and soft/safe synthetic chemicals to control the vector (Biopesticides e.g Nimbecidine; Achook 0.15%; Neemroc 0.03%).
- Use soft/safe synthetic chemicals to control the vector e.g. *Imidacloprid* 6-10ml/20L water to control maize thrips, aphids and leaf hoppers or *Lambda-cyhalothrin* 65ml/20L water to control maize thrips and leaf hoppers which are vectors of the virus.

Maize hybrids resistant to MLN for transitional to dry mid-altitude zones

WE7118, WE7118, WE6109, WE7117, KATEH16-01, KATEH16-02 KATEH16-03.

Fungal

Maize Common Smut disease

- Caused by *Ustilago maydis.*

Symptoms

- Galls (abnormal growths) develop on ears, leaves, stalk, or tassels
- Galls initially covered with white to silvery tissue.
- Later, dark masses of spores develop inside the galls.

Prevention

- Plant healthy and clean seed of resistant varieties.
- Practice crop rotation for 4 seasons with beans, tomato, maize, cassava and sweet potatoes.
- Remove and destroy severely infected plants by burning infected materials (smut disease spreads by air, seeds or soil).
- Use nitrogen fertilizers at recommended rates because excess/high nitrogen and injuries increase the potential for smut infection (or favours fungal growth).

Control

- Before the fungus bulbs burst and release black powder, move in the field and remove infected cobs/ plant parts, collect in a big plastic bag and dispose them away from the field.
- Bury or burn affected plant parts outside the maize field and do not use it for composting.

- Spray using Copper Oxychloride (Cuppracaffaro 70g/2 litres of water) and Atea 330 EC at 75 ml/20litres at booting stage/seed head still enclosed.

Do not re-cycle maize seed as it leads to more infection due to the build-up of disease inoculum resulting into reduced yield of Maize grain.

HARVESTING AND POST-HARVEST HANDLING

Maturity indices

Green maize is ready for harvest when the silky flowering at the top of the maize cob turns black.Dry maize should be harvested at physiological maturity.Maize is physiologically mature when:

- ✓ Most leaves have dried up.
- ✓ Cob husks are no longer green.
- ✓ Stalks turn yellow or brown.
- ✓ Cobs begin to droop on the stalk.
- ✓ Kernels show a black layer between the seed point and point of attachment to the cob.
- ✓ Grains re hard and not milky.
- ✓ Cobs are no longer good for roasting.

Drying of maize cobs

Methods of drying maize cobs

A maize crib

A maize crib is a well-ventilated store for temporary holding maize cobs till they are dry enough for threshing.

- Should be long and narrow, with wooden slats or chicken wire sides that allow free ventilation and a roof that protects against rain.

- The legs of the crib should be 1m above the ground level with rodent guards to keep rodents out
- Should be built across the prevailing wind to promote drying.

Drying maize in tarpaulins

Laying the crop out to dry in a thin layer on concrete drying floor, tarpaulin or mats

Don't let drying grain get wet, cover with a tarpaulin if it is about to rain, or at night time

Tarpaulin is a large plastic sheet or canvas that can be laid out in the sun for drying maize on cobs before threshing.

- Place the tarpaulin on flattened mound/hard-packed earth or on level ground with a shallow trench around to direct any rain water away from the drying floor.
- Remove any sharp objects on the grounds that may tear the tarpaulin.
- Place the tarpaulin on the place you have prepared.
- Place cobs in a single layer and turned at intervals of every hour.
- Protect grain from rain and night dew by covering the tarpaulin

Threshing/Shelling of maize cobs

- After drying select and sort healthy maize cobs. Remove cobs infected with diseases, moulds, attacked by pests and other visible damages.
- Thresh when the grain moisture content is around 14 - 15%
- Thresh/shell maize using a hand sheller for small scale or motorised grain threshing machine for large scale

Tractor maize grain shelling

Drying after threshing

Dry the maize grains after threshing to reduce the moisture content to the recommended safe moisture content for storage (13%).

Several options are available to smallholder farmers:

Sun drying

Solar wrap drying

Electric drier

Greenhouse solar

Winnowing

- After drying winnow the dry grains to remove premature grains, chaff, dust, foreign matter such as stones, shrivelled, mouldy, insect damaged, rotten discoloured or faded, and any remaining plant parts on the grains.
- You may winnow manually using a winnowing tray (*uteo*) or using motorised threshing and winnowing machine, to separate the dry grain from the soil matter before sorting.
- Sort the winnowed grain to attract a better price.

Storage

- Move out old grain from the store 5-6 weeks before harvest.
- Fumigate the store with pesticides.
- Keep grain clean, dry and cool to prevent moisture absorption, mold growth, quality deterioration and insect attack.

- Keep storage structure clean, dry and well ventilated.
- Have rat guards on the stands of grain stores to prevent losses due to rodent attack
- Use storage facilities that prevent moisture absorption, insect/pest attack
- Stack bags or containers with grain on pallets and off the walls (about 1 m away) to prevent moisture absorption.



MARKETS

- Kenya Agricultural Market Information System (KAMIS)
- Kilimo call centre

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