TOMATO ANNA F1

A GROWER'S HANDBOOK

DE RUITER SEEDS
HYBRID SEEDS

MONSANTO

Introduction

Tomato production in Kenya has increased considerably in the recent past with greenhouse production being adopted in many areas. The tomato *(Lycopersicon esculentum)* is popular with both small and large scale farmers for its edible fruits both for export and local consumption.

Monsanto hybrids rank highly amongst the reputable brands associated with tomato production in the country.

Tomato Anna F1 (Hybrid Tomato Anna) is an indeterminate hybrid bred and developed by the Monsanto Vegetable Seeds division for greenhouse production.

Tomato Anna F1 = Hybrid Tomato Anna

Features of Anna F1

- It is a fresh market variety that does very well in the greenhouse, but can also do well in open field.
- The fruit is deep red, firm and oval shaped.
- Tomato Anna F1 has High Resistance to Alternaria stem canker, Verticillium, Fusarium wilt as well as nematodes.
- Maturity is 75 days from transplanting.
- The yield is approximately 74tons/acre (80-90kg/m^2) with an average of 35 kg per plant in its life span.

Growing Instructions

For a successful crop of Anna F1 tomatoes the grower needs to diligently observe certain practices at each stage:

1. Field Selection

- Consider previous planted crop. As general rule, farmers should observe at least a 3-season break from tomato, pepper, potato or any other crop from the solanaceous family. This is done to avoid disease cycles and ensure less cost in disease management.
- Check the irrigation water quality. Excess sodium and fluoride may affect proper plant growth.
- Check water availability particularly if you intend to use irrigation.
- Ideally, the land should be gentle sloping to facilitate drainage.

2. Soil environment

- Tomatoes can grow in a variety of soil types; they do best in well-drained, deep, uniform clay or silty loams. The soil should be loose, deep and of correct structure because tomato Anna F1 has a root system of more than 60 cm depth.
- The optimum pH for tomato production is between 6-7.5.
- In coming up with a fertilizer program the grower can carry out a soil analysis.

3. Land preparation

- Proper land preparation is necessary to loosen soil and break hard pans or compacted fields. During land preparation, 8 tons of farm yard manure per acre can be incorporated into the soil to improve its structure, this will in turn improve soil aeration and water percolation.
- In nematode infested areas, fumigation can be done with registered products.
- In soils whose pH is low; lime can be applied to raise the pH. For alkaline soils, gypsum can be used to reduce soil pH; it is also handy in sodium-level reduction.
- Planting on beds is recommended for low-lying, areas with high run-off; Raise the soil 15cm high with walkways of 30cm between the beds. Lay drip lines with the nozzles facing up.

4. Seed requirement

- Tomato Anna F1 is sold in seed counts and is available in leading stockists in all the regions of the country.
- In calculating seed requirement, the amount of seed will be determined by the spacing that will be used. A plant density of 3 plants per metre squared is recommended for most regions. The grower should plant about 15 percent more seeds in their nursery to cater for the seedlings that will be used for gapping.

5. Nursery management

- Soil nursery method as well as trays can be used for growing seedlings. In the soil

nursery method, a fine tilth is recommended because of small sized seeds. The nursery should be raised 15 cm above the ground.

- Seeds should be planted at a depth of 1cm and a spacing of 15cm between the rows. The seeds are arranged along a furrow, and then covered lightly with soil.
- The nursery can be covered with hay or dry grass. This is done to increase moisture on the surface and prevent splash during irrigation. Watering will be done lightly using a watering can and timed in the morning to avoid conditions conducive for the development of diseases
- The seeds will sprout within 8 days. It will take about a month before the seedlings are ready for transplanting.
- Harden-off seedlings a week or two before transplanting by reducing irrigation.
- The farmer will be required to monitor the seedlings for pests, diseases and weeds using appropriate control methods when need arises.
- Farmers can also use trays for raising the seedlings. Plants raised in trays generally have a better survival rate.

Tomato Anna F1 Seedlings in trays

- Seedlings can also be sourced from a certified seedling raiser or nursery.

6. Transplanting

- The seedlings need about a month of growth before they are ready for transplanting. Transplanting is done using a trowel or a panga. When moving plants from the nursery bed, ensure that their roots are protected with a ball of soil - this lessens transplant shock.
- Transplanting is best done in the evening when the weather is cool.
- Transplant directly into already prepared holes. Spacing ranges from 60x45 cm, or 60x60 cm depending on soil condition and water availability.

Agronomic practices.

Agronomic practices include: nutrient management, irrigation, support, pruning, weeding, pest and disease management, harvesting and marketing.

i) Nutrient Management

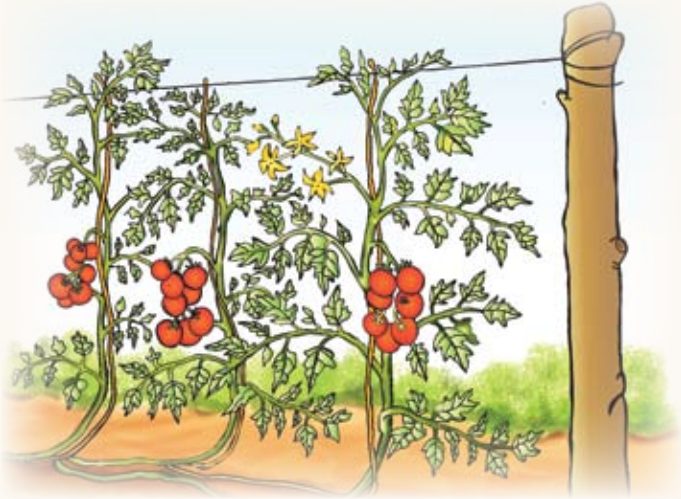
- Nutritional programs enhance proper plant performance. Crop nutrient requirements change with each stage of growth.
- The general principle is to apply Phosphate fertilizer as basal dressing for root development; for this, DAP or TSP can be used at the rate of 150Kg/ha. After transplanting, either Urea or CAN can be used for leaf establishment. Apply Urea after 2-3 weeks or CAN in the 5th week; both are applied at the rate of 200Kg/ha
- At the onset of flowering, top dress with NPK at 200Kg/ha; a compound fertilizer is necessary for the supply of N, P and especially K that is needed for flowering. The NPK top dress can be repeated after the first harvest.
- To correct micro-nutrient deficiencies, foliar feeds can be applied alongside the regular pesticide applications.
- Avoid excessive Nitrogen; it leads to excess vegetative growth, poor fruit set, smaller fruits, hollow fruits and poor keeping quality.
- Inadequate calcium can lead to blossom end rot disease; this disease can be corrected by applying calcium fertilizers.

(iii) Irrigation

- The amount and frequency of irrigation depends on prevailing weather conditions and the stage of growth. Avoid irrigation in the evening to prevent disease development.
- For a standard greenhouse of 240 square metres install a 500 litre tank, this will serve the plants for a single day - i.e. half a litre per plant per day.
- Apply water regularly during dry spells to reduce physiological problems. Irrigation should also be done after each harvest.
- Avoid excessive watering as this may lead to leaching of nutrients and water-logging.

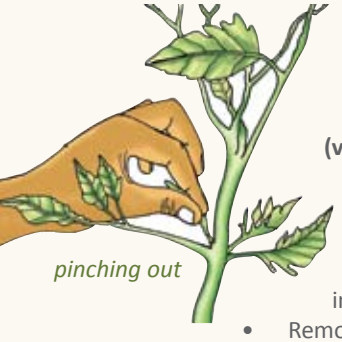
(iv) Support

- Plant support is done by trellising the tomato on poles and wires. This is usually done early - three weeks after transplanting - to avoid plant damage.
- Tie a string lightly on the tomato and then gently twine the string around the plant to avoid snapping the stem. Alternatively, a



peg can be inserted in soil just adjacent to the tomato and a trellis or string tied on to it and then tied on the barbed wire above, the tomato is then made to wind on the string.

- Supporting the crop allows free air movement and reduces moisture accumulation thus reducing disease incidences.



pinching out

(v)Pruning

- To avoid the spread of diseases from plant to plant, do not use secateurs or a knife, 'pinch out' instead using your thumb and forefinger.
- A weekly scouting is done for side shoots before they develop into big shoots.
- Remove side shoots, laterals, old leaves, diseased leaves & branches and overshadowed lower leaves by hand.
- After formation of the first fruit cluster of mature green tomatoes remove all the lower older leaves to allow for ventilation and disperse food to the fruits. (defoliation)
- Flowers should be pruned to 5-6 per cluster for medium- large sized fruits.

(vi) Weed management. The crop stand should be kept free of weeds at all time, because weeds compete for nutrients and are also vectors for disease. Hand weeding is recommended both for the greenhouse and outdoor tomatoes.

(vii) Pests and Diseases

- Always scout for pests and diseases in the morning because this is the best time to get all the pests on the plant. Common pests include; Aphids, thrips, whiteflies, cutworms, bollworms, leaf miners, spider mites and nematodes.
- Common diseases include: Wilts, Blight, Leaf spots and mildews.
- For the control of pests, cultural methods are the best e.g. clean weeding, use of certified seed, destroying alternate hosts etc.
- Do not wait till the pest or disease symptoms begin to show. Carry out preventive spraying, observe the product label recommendations in each case. For diseases e.g. mildews, blight, copper-based or sulphur-based fungicides are used.
- Viral diseases can be controlled by controlling vectors. Key vectors include; aphids, thrips, whiteflies and nematodes.

Harvesting

- Anna F1 is ready for harvesting in 70 to 75 days depending on weather.
- Usually the very first cluster bears the first ready fruits.
- Pick fruits at intervals as they ripen depending on your market demand. The very first harvest is usually less compared to the later harvests. Hand pick and place fruits in crates when the weather is cool.
- Harvesting continues for up to 6-8 months.
- Once the plant reaches the top, (approximately 2 m long or the height of a normal person standing with arms stretched upwards), laying is to be done. Bring the tomato down, bending it on the ground and trellising it on a string as done initially.
- Observe the pre-harvest period incase any chemical was sprayed. Watering must be done immediately after every harvest.

Marketing

Tomato Anna F1 has excellent fruit quality for the market, oval shaped, deep red in colour, and firm with good grade-out.
The fruits are accepted in the local market, supermarkets, and other consumption institutions because of their quality.
When targeting specific markets, grade before selling by sorting out according to size, colour, or weight.

Growing Systems

1. Greenhouse Methods.

Due to improved environment production of the tomato plant is optimized. A farmer can decide the spacing to use depending on the area and climate. Commonly used spacing is 60 by 60 cm for double stem spacing or 60 by 45 cm single stem system.

(a) For the 60 X60 cm, two strong leading shoots are left to bear the fruits. All other shoots are removed as early as possible by snapping them off carefully by hand. Selected branches are vertically supported by trellises or staking.

Single Stem System

Double Stem System

(b) For the 60 by 45 cm, only one strong and dominant shoot is left to grow and bear fruits. All other shoots are desuckered in time.

2. Outdoor Methods

(a) Staking Method

- In this method, 5-6 ft long stakes are used to support the plant vertically at 60 cm intervals.
- Both single and double stem systems can be used.

(b)Passion fruit method

- Here strong stakes 9 ft high are erected above on which a strong wire, preferably barbed wire is set from post to post.
- Prune to either single stem or double stem.

(c)Hedge type method

- The idea is to maximize production within a small period of time. The crop is planted at 60by60 cm and left to grow on 5 branches.
- The weak branches are removed in time.
- Each branch is nipped at a height of 1.5-2 meters which is 5-7 trusses.
- The supporting is done by setting strong stakes on which double stringing is done to support the tomato from all sides to look like a hedge, (snow peas system.)

General Management of pest and diseases

Pests and diseases remain the greatest challenge in Tomato production. Appropriate and timely management makes all the difference between good production, poor production or total crop failure. Proper identification of the pest and disease is critical in a control strategy.

The general principles in pests and disease management include;

- **Practicing crop rotation.** Observe minimum 2 year rotation program
- **Planting resistant /tolerant varieties -** Use certified disease-free seed treated with an approved fungicide to control seed rots and post emergence damping off
- **Field hygiene**-old crop should be removed from the fields, control weeds and crop debris since these are source of pests and diseases. Staking and pruning are also key to disease incidence reduction
- **Using proper crop production practices** that provide the right growing conditions for plants (sufficient water and balanced fertilization), particularly when crops are young. Strong healthy plants are more likely to withstand pests and diseases.
- **Irrigation management**; poor irrigation timing and scheduling may lead to disease, overhead irrigation in the evenings can encourage early blight.
- Ensure regular **crop scouting** for pest and disease as well as weed and nutrient deficiencies. Proper pest and diseases identification is the first and critical step in their management. This helps to detect problems early and take control measures on time.

NOTE: Use registered products at the recommended rates observing the PHI; Refer to product label.

MAJOR TOMATO PESTS

The greenhouse whitefly *(Trialeurodes vaporariorum)*

This pest is serious as it has a very high multiplication rate, the whitefly larvae stages are also difficult to control with conventional contact products. The pest populations build up rapidly due to a life cycle of 20 days or less. Greenhouse Whitefly is a key vector to various viral diseases such as Tomato Yellow Leaf Curl Virus.They usually cause stunting and growth of sooty mould. Poor fruit are formed. The pest is known to transmit viruses.

Control of whiteflies

Physical control –use of nets and double doors, sticky traps and destruction of infested debris, registered pesticide products can also be used.

Leaf miner *(Liriomyza huidobrensis)*

The adult leaf miner causes damage on the leaves with the feeding marks. The larvae tunnel the leaf reducing the photosynthesis area and often destroying the leaf. Heavy infestation can lead to loss of leaves and even death of the plant. When leaves are damaged the yield for that plant will be direct affected.

Control of Leaf miners

Biological control using Diglyphus, disease and cultural control such as burying plant residues. For insecticide use refer to table (pg 13).

Important Diseases in Tomatoes

Late Blight - *Phytophthora infestans*

The disease is very common particularly during the rainy season but also when there is excess moisture or humidity in the green house. This disease can spread very fast wiping away plants within a short time. The disease also affects fruits.

Effects of the disease

The disease forms irregular greenish or water soaked lesions on the leaves, stems and fruits. Leaves develop bluish-grey patches, turn brown, wither but stay attached to the plant. Fruits develop watery spots which develop on upper half of fruit. The disease leads to rapid death of the entire plant.

Disease management

Crop rotation, management of nitrogen and field hygiene. Pesticides available include Azoxystrobin, Mancozeb, Propineb, Chlorothalonil, Metalaxyl, and Copper Oxychloride among others.

Image: Yuan-Min Shen, Taichung District Agricultural Research and Extensi

Bacterial Wilt - *Ralstania solanacearum*

Bacterial wilt is one of the major diseases of tomato. The disease is known to occur in the wet tropics, subtropics and some temperate regions of the world. The pathogen can also cause the bacterial wilt in several major crops such as eggplant, pepper, potato, tobacco and tomato. This disease is one of the major challenges tomato farmers face.

Image: Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org

Symptoms

Symptoms consist of a non-yellowing wilting of the youngest leaves at the ends of the branches during the hottest part of the day . During its early stages, only one or half a leaflet may wilt and plants may appear to recover at night, when the temperatures are cooler. As the disease develops under favorable conditions, the entire plant may wilt quickly and desiccate although dried leaves remain green, leading to general wilting and yellowing of foliage and eventually the plant dies.

Control of the disease

- No chemical control available
- Cultural practices such as crop rotation field hygiene and irrigation water management can help
- Growing resistant root stock, these are available from Monsanto vegetable seed.

Fusarium wilt - *Fusarium oxysporum f.sp. lycopersici*

Tomatoes may be infected at any age by the fungi. The wilt organisms usually enter the plant through young roots and then grow into and up the water conducting vessels of the roots and stem.

Symptoms

First symptoms are yellowing of the foliage, beginning with the lower leaves and working upward. Yellowing often begins on one side of the vine. Infected leaves later show downward curling, followed by browning and drying. The top of the vine wilts during the day and recovers at night, but wilting becomes progressively worse until the entire vine is permanently wilted. Vascular browning can be seen in infected stems and large leaf petioles. If the main stem is cut, dark, chocolate-brown streaks may be seen running lengthwise through the stem. This discoloration often extends upward for some distance

and is especially evident at the point where the petiole joins the stem. Affected plants and their root systems are stunted. The degree of stunting depends upon time of root infection. Plants infected when they are young will be more severely stunted than plants infected at a later stage.

Control

- Plant raised beds to promote soil water drainage away from roots
- Thoroughly disinfect equipment before moving from infested to clean field.

Early Blight - *Alternaria Solani*

The disease is common in harvesting plants. In poorly managed green houses the disease can wipeout if timely management is not carried out. Disease development is most serious during warm wet conditions. Tomatoes infected with early blight develop small dark brown to black spots on lower shaded leaves, stems and fruits. Leaf spots are boarded by a concentric leathery tissue. Spots in fruits often occur near the calyx end of the fruit.

In the seedbed the small plants wilt and die eventually. In older crops, stem death occurs while leaves fall off the crop and fruits drop prematurely.

Control of the disease

Crop rotation is key in managing the disease. Infected crop debris should be disposed off well to avoid re-infection but also not act as source of inoculums.
Use of certified disease free seeds as well as tolerant varieties can also help.

Fungicide use can also help to reduce spread and also cure disease plants ; Some of the effective chemicals available include Chlorothalonil, Mancozeb, Propineb, Cymoxanil, Azoxystrobin and Propamocarb.

Powdery Mildew - *Leveillula taurica*

Symptoms of the disease occur only on the leaves. Symptoms initially appear as light green to yellow blotches or spots that range from $^1/_8$ - ½ inches in diameter on the upper surface of the leaf. The spots eventually turn brown as the leaf tissue dies. The entire leaf eventually turns brown and shrivels, but remains attached to the stem. A white, powdery growth of the fungal mycelium is found on the top of leaves. The fungus produces specialized feeding structures called haustoria that invade host cells to extract nutrients.

The removal of nutrients from host cells causes the yellowing and eventual necrosis of tomato tissue. The plant is not killed by this disease, but is progressively weakened and productivity greatly decreased.

Control Method

Greenhouses typically provide ideal conditions for disease development and spread. An integrated approach should be used to control powdery mildew in the greenhouse. Practices that maintain high relative humidity should be utilized. Infected plants should be removed from the house, which should be sanitized after production. Registered fungicides should be applied to plants as soon as symptoms are observed.
control measures would include scouting, rouging of infected plants, use of resistant varieties, and spraying preventative chemicals.Azoxystrobin, Myclobutanil, Triforine, Thiophanate, Tebuconazole, and Sulfur based fungicides among others have given satisfactory control.

Bacterial Canker -*Clavibacter michiganensis subsp. michiganensis*

Symptoms may be noted on leaves, stems, and inside fruits. Areas of leaves above the second or third cluster may show dull green and water-soaked areas, which later appear desiccated and become necrotic. Wilting progresses until the entire leaflet dies. Close examination of stems reveals open cankers. Splitting of the stem lengthwise reveals reddish brown discoloration. The pith becomes granular to mealy and filled with cavities. On fruits there is formation of yellow brown spots, slightly raised and surrounded by a white birds eye like halo spot.

Bacteria can occur on the seed coat as well as within the embryo. Seedborne inoculum may serve as one source of the disease. Early recognition of the disease, especially in greenhouse crops, is essential if the disease is to be contained. The organism is seedborne and can survive for short periods in soil, greenhouse structures, and equipment and for longer periods in plant debris

Control of the disease

Cultural control methods such as using tolerant varieties, certified disease-free seeds, practicing crop rotation, proper disposal of infected plant material and managing watering by reducing overhead irrigation. Use of tools such as pruning knifes can also spread the disease from one plant to another hence, they should be sanitized. Fungicides that can be effectively used include Copper based fungicides, Carbendazim and Thiabendazole. Affected plants can be uprooted to reduce spread.

Table of common pests and diseases and their management

Pest/Disease	Pest stage	Affected Part	* Products to Use
Whiteflies	Adults	Leaves	Synthethic pyrethroids, Oxymyl, Chlorpyrifos, Dimethoate, Oxamyl
	Larvae	Leaves	Pubrofezin, Abamectin and Thiacloprid
Leaf miner	Adults	Leaves	Oxamyl, Imidacloprid, Azadirachtin, Dimethoate, Acephate, and Thiacloprid
	Larvae	Leaves	Abamectin, Spinosad, Cyromazine
Spider mites	All stages	Leaves and stems	Synthethic pyrethroids, Oxymyl, Abamectin
Aphids	Adults	Stems, leaves and flowers	L-Cyhalothrin, Pimicarb,
Thrips	Pupa, adults	Flowers and leaves	Spinosad, L-Cyhalothrin, Oxamyl
Caterpillars	Larvae	Leaves and fruits	Synthethic pyrethroids
Nematodes	All stages	Roots	Azadirachtin, othoprophos, Metam sodium
Late Blight		Leaves and stems	Azoxystrobin, Mancozeb, Propineb, Chlorothalonil, Metalaxyl, and Copper Oxychloride
Early blight			Chlorothalonil, Azoxystrobin, Mancozeb, Metalaxyl,
Bacterial wilt			Copper Oxychloride, Copper oxide
Root rot	Fusarium, Pythium Rhizoctonia		Chlorothalonil, Metalaxyl,
Powdery mildew			Tebuconazole , Azoxystrobin, Mancozeb, Chlorothalonil, Metalaxyl,
Downey mildew			Propineb, Chlorothalonil, Metalaxyl, Azoxystrobin, Mancozeb,
Bacterial speck			Copper Oxychloride, Copper oxide
Viral infections			Uproot and control vector

* This list is adopted from the PCPB pesticide products guide. Products have been registered for use under various brand names. Use according to the recommended guidelines on the product label.

Glossary

Basal dressing: Refers to the placement of fertilizer around but not in close contact with the seed or seedling for the sole purpose of nutrient supply to the roots.
CAN: Calcium Ammonium Nitrate; a high Nitrogen fertilizer for top dressing.
DAP: Di-Ammonium Phosphate; a basal placement fertilizer applied during planting
Gapping: Processing of filling in dead or missing plants in the field to maintain plant population.
Double stem system: Plant training method used in tomatoes to achieve more yield in a short term.
Gypsum: Rock salt used to manage high sodium content in soils but also to supply calcium and reduce soil pH.
Harden-off: Process of exposing the seedling to harsh conditions similar to those in the field.
Indeterminate tomatoes: Tomatoes that don't stop growing, and produce over a long time.
K: The periodic table symbol for Potassium; a mineral element required in high quantities during flowering and is responsible energy metabolism.
Nematode: Small thread-like organisms that damage crops by causing abnormal swellings on their roots (Galls) and stunting among many effects on the plant.
N: The periodic table symbol for nitrogen; a mineral element that is required in making plant tissues, usually needed in high quantities in young plants.
NPK: Compound fertilizer that is formulated to supply at least three major nutrients (Nitogen, Phosphorus and Potassium) required for plant growth. Recommended application time is few weeks before and after flowering.
P: Periodic table symbol for Phosphorous; a mineral nutrient required for shoot and root development, applied during planting.
pH: A measure of the acidity or alkalinity, numerically equal to 7 for neutral solutions, increasing with increasing alkalinity and decreasing with increasing acidity. The pH scale commonly in use ranges from 0 to 14.
PHI: Pre Harvest Interval; a period in days from day of pesticide application to the day when harvested is permitted.
Single stem system: a system of plant training where only one stem is allowed to grow, the method commonly used in greenhouses.
Solanaceous crops: These are crops of the solanun family they include: tomatoes, potatoes, tobacco, eggplants, peppers, chilies.
TSP: Triple Super Phosphate; a phosphate fertilizer recommended for acidic soils, used as a basal dress.
Transplant shock: Negative plant reaction of the transplanted seedling caused by new and unfriendly conditions in the field as compared to the conditions in the nursery.

Cost Benefit Analysis for Drip Irrigated Greenhouse (Tomatoes)

	Year 1		Year 2	
Area : 240m2	**First 6 months**	**Next 6 months**	**First 6 months**	**Next 6 months**
Output (kg)	7,000	3,000	7,000	3,000.00
Farm-gate price average (Ksh/kg)	40	40	40	40
GROSS REVENUE (KSH/240M²)	**280,000**	**120,000**	**280,000**	**120,000.00**
COSTS				
Variable costs				
Beds Preparation				
Primary Tillage	200		200	
Secondary Tillage	200		200	
DAP 10kg	700		700	
NPK 17:17:17 50kg	2,750	2,750	2,750	2,750
Transplanting pesticides	1,000		1,000	
Field Pesticides	1,500	1,500	1,500	1,500
Fungicides	3,000	3,000	3,000	3,000
Manure 2 tons	4,000		4,000	
caretaker @ 5,000 p.m.	30,000	30,000	30,000	30,000
1000 seedlings @ ksh 3 each	3,000		3,000	
Fixed costs				
Green house Construction: Includes timber plastic sheet, nails and labour.	210,000			
Others- transport, casual labour etc	10,000	5,000.00	10,000	5,000.00
TOTAL COST OF PRODUCTION (KSH)	**266,350**	**42,250**	**56,350**	**42,250**
PROFIT (KSH/ 240M²)	**13,650**	**77,750**	**223,650**	**77,750.00**
	91,400		**301,400**	

Disclaimer: Performance of our seed may be adversely affected by environmental conditions, cultural practices, diseases, insects or other factors beyond our control. All information concerning the varieties and their performance given orally or in writing by Monsanto or its employees or its agents is given in good fatih, but is not to be taken as a representation by Monsanto as to perfromance and suitability of the varieties sold. Performance may depend on local climatic conditions and other causes. Monsanto assumes no liability for the given information.

MONSANTO KENYA LTD,
TUSKYS HEAD OFFICE COMPLEX, MOMBASA RD.
P.O. Box 47686, 00100, **NAIROBI, KENYA**.
Tel: 254 20 2060922/44, 3574301/4, Fax: 254 20 823086, 3574300.
Cell: 254 722 205594, 722 205294, 722 205529, 254 733 600468, 733 629414
www.monsantoafrica. com

MONSANTO