PAWPAW GROWER'S MANUAL

Scientific name: Carica papaya

Local name: Swahili name: Papaya



1. Introduction

Pawpaw, also known as papaya or Papita (*Carica papaya*,) originated from tropical America specifically Mexico and Costa Rica. Papaya is a short season crop starting to produce at six months up to four years for hybrids depending on variety. Local varieties produce up to ten years; the crop can grow to up to height of 2-4 meters for improved varieties while the local grows to up to ten meters.

1.1 Producing counties

In Kenya Pawpaw is produced in Mombasa, Meru, Machakos, Makueni, Baringo, Kitui, Embu, Homabay, Muranga and Kirinyaga.

1.2 Uses

Pawpaw is a popular fruit in Kenya used as a dessert, green fruits used as pickle or cooked as vegetable. It also has uses in beverage, food and Phamasticals industries as well as health benefits.

1.3 Ecological requirements

Papaws do well in warm climates of the tropics. They can grow in cold and winter climates. However, these affect both growth and production, leading to prolonged maturity periods and low sweetness of fruits. The optimum ecological requirements are: Temperatures $-21^{\circ}c-33^{\circ}c$.

Annual average rainfall - 1000mm

Altitude 0-1500M above sea level.

Soils- Light well drained rich in organic matter.

PH of 6.0-6.5

1.4 Varieties

Selection of crop, variety and quantities should be informed by the market survey information. This will also inform on the planting calendar to be followed to ensure availability of the product to the market at the right time.

Lately, many varieties of the pawpaw are grown. However, the common varieties planted include Solo, Solo sunrise, Red lady, Mountain, MalkiaF1 with more local varieties. The seeds are available in Kenyan agricultural related canters e.g. KARLO Perkera in Baringo and from seed importers.

Variety	Average size	Fruit color	Productivity	Durabilit
			/year.	У
Solo sunrise	A tall variety maturing at 6 months	Pink in color pear shaped, very sweet	170 fruits of 350-400gms	Excellent shelf life
Solo	400gms.round fruits	yellow in colour	150 fruits	Good shelf life
Calina	A dwarf variety producing at 30cm and maturing at 8 months	Red in colour with oval fruits	Produces about 100- fruits weighing1- 1.5kg	Good shelf life
Malkia f1	Dwarf maturing at 8 months	Red fleshed round shaped fruits	80-fruits weighing 1.5- 2 kgs	Good shelf life

Red lady	Dwarf maturing at 9 months	Red oval shaped fruits, smaller	100-fruits weighing 300/600mgs	
Mountain	Maturity starts from 8months	Fruits are round in medium in size, yellow or orange in colour	200g	Good storage quality

2.0 Good Agricultural Practices (GAPs)

Horticulture industry in Kenya is guided by a code of practice KS1758- which is a standard for flowers, vegetables, fruits, herbs and spices for both local and export market. The standard aims at ensuring food safety, environmental sustainability and social accountability by following good agricultural practices from production, processing, transportation and marketing of fresh produce. It aims at increasing production and productivity of scheduled crops in relation to charging climate.

The manual seeks to adopt climate smart technologies aimed at increasing production and productivity, enhancing resilience and reducing greenhouse gas emissions. It is also essential to maintain accurate records for all operation for ease of traceability.

2.1. Land preparation.

The land should be ploughed and harrowed to a loose crumbly soil texture to ensure good aeration and improved drainage.

Make elevated bed on which rows of pawpaw would be planted allowing for proper irrigation and drainage.

Organic fertilizer and manure should be spread and incorporated in the soil during land preparation.

Plant pawpaw preferably on virgin land with less disease and insect pressure.

Farmers can also use virgin soil technique-feeling planting holes with virgin soil before planting to allow seedling to establish its roots on virgin soil.

2.2 Soil testing and water testing

Soil and water samples from the land should be collected and analyzed to determine nutrient levels and salt levels.

This analysis can be done by local commercial laboratories or by other established Agricultural research institutions. The laboratory results gives recommendations on adjusting soil pH and the amounts of other soil nutrients needed.

2.3 Planting and Spacing.

All planting materials should be acquired from registered and certified nurseries or reputable stockists. Transplant seedling at a height of 10 to 15 cm. Older and bigger seedlings have great chances of surviving and growing into stronger healthier trees Compared to younger seedlings.

Transplant seedlings at spacing of 3mx3m, and holes of 60cmx60cm. Water immediately after transplanting.



Fig1: Illustration of a planting hole for Pawpaw



Fig2: Illustration of a planting spacing for Pawpaw

Apply a mulch on the beds to reduce water loss, control weeds and avoid infections at young stage.

The most common practice is the use of seeds at the rate of 20gms per acre purchased from reputable sources, otherwise acquire ready seedlings from registered nurseries at 450 seedlings per acre for the spacing of 3mx3m.

Grow two to three seedlings in each hole until flowering then eliminate some of the plants to get the required female to male ratio of 1:8.



Fig.2: Flowering male plant.



Fig.3: Flowering female plant

2.2 Crop Management

2.2.1 Crop water requirements

Crop water requirements depends on prevailing climatic conditions, soil conditions and growth stage of the crop.

Although paw paws have a considerable level of drought resistance, sufficient water is required for optimum growth especially during flowering and fruit development stages. Lack of sufficient water may drop flowers, leaves and young fruit and produce small fruits of low sugar content. Adlib drip irrigation is therefore important in areas that receive low rainfall preferably through drip irrigation.

2.2.2 Crop nutrition.

Pawpaw trees need continuous fertilization since fruiting is continuous after the tree attains maturity.

One week after transplanting, apply about 28g (handful) phosphate fertilizer e.g. N:P:K 12:24:12, to each plant. Then 57g (two handfuls) of nitrogen fertilizer e.g. 20:10:10 weekly. Potassium is important during the flowering and fruit setting stages of the pawpaw plant. Apply 144g of potassium fertilizer (such as N:P:K 12:12:17+2) per plant at first sight of flowers. This application should continue every month.

Foliar fertilizer containing trace elements especially Boron every month. This helps in ensuring good fruit quality. Organic fertilizers is also used for growing pawpaw. It is recommended you apply 10 tons of compost or manure per hectare (or 1 kg per square meter) before planting or when forming beds. The same amount should be applied every year for adult plants.

Fertilizer should be applied at the base of each tree. Avoid excessive application of manure and other organic fertilizers against soft fruit.

2.2.3 Weeding and Mulching.

Weeding starts at the young stage when still in the nursery beds. This should be done frequently and lightly. After transplanting, hand weeding is recommended around the young seedlings.

Mulching the field with plastic biodegradable films before transplanting or with rice / sugarcane straws before or within a few days after transplanting. This is a very effective and recommended method that you can use to control the weeds, soil erosion and water loss and release of nutrients on decomposition of the organic matter.

2.2.4 Thinning

Thinning is done to reduce competition for nutrients among the plants and to retain enough plants to ensure that the right ratio of male to female of 1;8 is achieved. Thinning is done at the flowering stage 6 to 8 months when all undesired trees are cut off at ground level leaving one hermaphrodite plant.

2.2.5 Removing suckers

All suckers should be removed as soon as possible to avoid damaging the maturing fruits.

2.2.6 Pruning and Orchard sanitation

The removal of all old or dead leaves from the plant. Leaves, petioles and fruits infected by diseases must be removed and destroyed away from the orchard.

2.2.7 Plant support

When plants bear heavy especially on an inclined field, they must be supported to prevent the stem from breaking. This should also be done in areas that frequently experience storms by supporting with ropes tied on pegs fixed firmly on the ground or by propping using poles of wood or bamboo.

2.2.8 Hand pollination

It is advisable to pollinate the plants by hand to increase the fruit setting and the percentage of large and normal fruits. This is actually necessary when growing paw paws under a net house.

2.2.9 Pest and disease Control

Even though pawpaw plants are considerably tolerant to pests and diseases, they are not totally free. A number of pests and diseases attack pawpaw. These vary depending on the prevailing environmental and managerial conditions.

Integrated crop management is the best option for food safety. These practices include scouting of the pests, field hygiene, proper spacing, physical methods, and biological methods like use of the pheromones, traps and others that will only give options for using pesticides as last option. The products should be registered for use in Kenya on the crop. www.pcpb.go.ke/-of-registered-products/

Pests and diseases	Symptoms	Control		
Mealy bugs-paraccocus marginatus	Sooty mold on underside of leaf, stems and branches. defoliation, wilting, chlorosis, stunted growth, premature fall	-Biological control by releasing the parasite that feed on the mealy bugs -Apply insecticidal paints, insecticidal soaps, of chilly sprays		
Spider mites-tetranyclus spp	Causes webbing on leaves as bleached punctures on the leaves .premature leaves drop and plants become weak	-Biologically use parasitic wasps -Use of organic/neem products.		
Fruit fly-drosophila melanogaster	Fruit turn yellow prematurely and drop from the tree Are minor insects but may cause certain damages to paw paws	-Ensure field hygiene -Use fruit fly traps		

Major Pests and Diseases.

Scales(White beach scales)- pseudaulacicaspis pentagona	- Small black or brown insects that damage by feeding on twigs, branches or fruits. produce white or waxy coating which turns black	use natural enemies like the predacious beetles -spray with horticulture oils	
Pawpaw ring spot virus and leaf spot – The spot – PRSV-P	Vein banding with yellow colour along veins, mottling, leave distortion and water soaking streaks, stunted growth and reduced fruit size and sweetness (first spread limiting factor in	-Grow tolerant varieties e.g. the solo and red lady -Intercrop with barrier crops like corn -Control aphids -Ensure cleanliness/Sanitation	
Dumping off-Pythium spp	-Seeds may fail to germinate -Seedlings rapidly wither and die even with watering stems shrivel then collapse. -Leaves are marshy, discolored and coiled. -Seedlings wilt and fall then die.	 -Use virgin or sterile soils -Grow in well drained soils. -Use soil fumigants. -Sterilize the soil before using -Provide favorable environmental conditions 	
Phytophthorafruitrot-Phythophthora palmivoraImage: state	Occurs in hot and humid season affecting root. young and adult plants wilt and die . forms large lesions and white mould on fruits then fruit drops	-Crop rotation. -Well drained soils, remove and deep burry the affected fruits -Spray dithanem-45wp weekly	

Powdery mildew-Erysiphe	White gray powder mounds appear on leaves stems and young fruits, stunted growth induced leaf dropping and fruit fail to set	-Use neem oil products and soap solutions.		
Anthracnose- Colletotrichum gloeosporioides	Dark sunken spots on leaves, stem. black brown spots on the fruits	Hot water treats fruits at 49 for 20min then dip in cold water for 20min		
Black spot- Pseudomonas spp	Greyish white circular in shape, infected leaves turn yellow and dry. Spots on fruits are tiny water soaked. More serious in wet and cool places at hill side	Refer to anthracnose control		
Phytophthora root rot- Phytophthora citrophthora	Roots become stunted or yellow. Wilting of the leaves yellowing of the fruit and death of plant. Decay, leaf yellowing, and failing plant after raining. It also kills young seedlings in the nursery.	 -Rotating pawpaw with other crops -Maintaining good drainage on the field and nursery, -Sterilization of the nursery bed with formaldehyde two weeks before sowing or treating the seeds with thiram (TMTD) or captan. 		
Stem rot-Sclerotinia sclerotiorum Image: sclerotinia	A dry, firm, dark rot usually occurs after picking. Starting at the stem end and extends into the fruit.	Pick the fruits with part of peduncle.		

Root rot	nematode-	Root nematodes are -Crop rotation
Meloidogynes pp		microscopic roundworms -Improved drainage
		that infest the plant roots -Spray crop with
12 Anna		causing swelling or nematicide
ALL AND ST		retardation of the root
		and stunting of the plants
Boron deficienc	y	Gall like malformation of -Use organic manure.
Bar Bar of Lin		fruits. Fruits are hard and -Dissolve borax in hot
the Print of	- 32	not easy to get ripe, water then spry 0.25%
	5 W	tasteless and loose borax solution on the
all the set	100	commercial value leaves at the beginning of
		the season along with
		fertilizers.
		commercial value the season along with fertilizers.

2.3. Harvesting

Generally, pawpaw fruits mature and be ready for harvesting around the ninth month after seed sowing with those in hotter regions maturing faster than those in cooler areas.

2.3.1 Maturity indices

Pawpaw fruits to be used as vegetable (fruits for cooking) are harvested while still green but mature. Papain turns from being milky to almost a colorless liquid.

Pawpaw fruits for ripening should be harvested when yellow color traces start appearing on the green fruit. It is advisable to harvest the fruits when about 25% or 1/4 of the fruit surface turns yellow or orange.

2.3.2 Harvesting techniques

Hand picking is done for shot tree. Use of Plumber's plunger is used on tall trees. Ladders may be used but this increases the chance of the tree trunk becoming affected by bacterial diseases as a result of injury.

Latex gloves are worn to avoid finger nail damage to fruits. Harvesting is done using a sharp knife dipped in a bleach solution. Allow latex to drain, or, wipe off the latex on a cushioned surface to prevent fruit from being stained.

Never drop fruits to the ground instead use poles to snap the fruit from the tree.

2.3.3 Expected yields.

On average a pawpaw tree will produce 50 fruits in a year with plant population of 450 plants in an acre hence expected yield of 22,500 fruits per year is achievable.

2.4 Post-harvest handling

2.4.1 Sorting

The harvested fruits should be placed gently on baskets with soft padding for delivery to the packinghouse within 2-4 hours from harvest.

Heavily bruised, damaged, over-ripe or old fruits and those that have been affected by diseases are sorted out and discarded.

2.4.2 Fruit treatment

Wash and treat the healthy quality fruits by dipping them in hot water (for about 10 minutes in water that is approximately 52°C). Allow the washed fruits to dry in air under a shade. Do not expose the harvested fruits to direct sunshine.

2.4.3 Packaging and transportation

Ripe paw paws are best transported in wooden or hard plastic fruit crates. The fruit crates hold them firmly not to rub against each other during transit to the market. Paper fillers can also be used to ensure that the fruits are firm in the crate. It is advisable to wrap each fruit in paper before packing if the product is for export. The bottom of the crate should be cushioned to protect the fruits.

Pack fruits in one layer with the peduncle facing the bottom for papain to drains and gets absorbed by the shredded paper. The field crates containing the fruits should be left under shed protected from the sun and rain. You should never use mesh bags, sacks or baskets for pawpaw transport to avoid bruising the fruit.

3.0 Gross margin analysis for pawpaw production per acre as at 2024

Item	Unit	Quantity	Cost/unit (Ksh.)		Amount in Kshs			
				year 1	Year 2	Year 3	Year 4	
Cross income 450 trees spacing 3mx3m.4yrs 50 fruits/tree/year	Pcs	22,500	30	675,000	787,000	900,000	675,000	
Variable costs								
Land preparation	md	1	4000	6,000	-	-	-	
Hole making	md	450	50	22,500	-	-	-	
Planting labour	md	10	500	5000	-	-	-	
Seedlings		450	50	22500	-	-	-	
Transport costs		1	3000	3000	-	-	-	
Fertilizer(DAP,,,NPK,FOLIAR)	Mls	2	4,500	9,000	9,000	9,000	9,000	
Manure	tons	10ton	1000	10.000	12,000	14,000,	14,000	
Pesticides, Insecticides	mls	-	6,000	6,000	8,000	10,000	10,000	
Labour costs								
Weeding-monthly	md	10x4	500	20,000	40,000	40,000	24,000	
Irrigation-fortnight	md	8x6	500	24,000	48000	48,000	24,000	
Spraying- Monthly	md	8X6	500	24,000	24,000	24,000	8,000	
Harvesting-weekly	md	4X12	500	24,000	24,000	24,000	8,000	
Packaging	md	4x4	500	8,000	8,000	8,000	177,000	
Total variable costs				184,000	173,000	177,000	177,000	
Gross margin(Total income-Total variables)		491,000	614,000	899,823	4,498,000			

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