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uMnyango weZolimo neZemvelo

FRUIT & NUT PRODUCTION IN KWAZULU-NATAL

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FRUIT AND NUT PRODUCTION IN KZN

CONTENTS

INTRODUCTION

Successful production of fruit and nut crops requires careful planning from the outset. Capital inputs are high, especially if hail netting is required, and, except for certain early bearing crops (papayas, granadilla), income cannot be expected for a number of seasons. The final decision on the specific permanent crop to be established should be based on climate, cultivar suitability, the physical features of the land available (slope, aspect) and on the grower's perception of future demand (local and export markets) and thus price prospects.

Each fruit or nut type has specific tolerances which will determine whether optimal production can be achieved or not. All crops will do well in deep, well- drained soils, but some types and rootstocks demand better soils more than others.

Climate is the most important environmental variable affecting the production of fruit crops. Some of these factors include: light, temperature, rainfall, evaporation, relative humidity (RH) and wind. Temperature is the most important of these variables due to its critical influence on plant growth, so most fruit types are divided into categories based largely on temperature requirements. Available records of mean maximum and minimum temperatures for each month, as well as humidity and rainfall data, should be examined in order to determine what crop types are most suited to the conditions.

Tropical fruits grow in areas where there is little variation in day/night temperatures throughout the year. The mean monthly temperature during the coolest month (July) is 18℃ or higher. All the crops require large amounts of heat (*i.e.* heat units) for fruit ripening and few will tolerate any frost during the growing season, *e.g.* bananas, papaya, coffee, cocoa, litchi, custard apple, cashew, date palm and coconut

Subtropical crops grow in areas having a mean July temperature between 13 and 18℃. There is generally a distinct wet and dry season, with a seasonal temperature range. Most subtropical crops tolerate light frosts but not severe frosts, especially during flowering and fruiting, *e.g.* citrus, avocado, mango, figs, pineapple, guava and macadamia.

Temperate crops prefer a mean temperature for the coldest month of less than 13℃. The main feature of temperate fruits is that they need a cold dormant period (winter chilling) to flower and set fruit satisfactorily in spring. They can withstand severe frosts during their dormant period but are susceptible to late frosts during flowering and early fruiting stages. These crops are suited to the cold Berg areas and some interior river valleys of KZN, *e.g.* apples, peaches, plums, cherries, apricots, kiwifruit, almonds.

Most fruit trees are propagated by grafting a specific cultivar onto a rootstock. These grafted trees must be ordered from a nursery at least a year before the expected planting date. Tropical and subtropical fruit trees may be planted at any time of the year but the best time is August to September after the last frosts. Mid summer should be avoided. Bananas are an exception as planting time is critical to when the plants throw their bunches. Trees are generally evergreen and are purchased in bags from the nursery as the roots are sensitive to being disturbed. Deciduous fruit trees are planted from the end of July to mid August, depending on the type of fruit tree. The trees are dormant at this time and suffer little stress during the planting process. When trees are planted out they should be planted at the same depth as they were in the bags.

1. TROPICAL & SUBTROPICAL CROPS

1.1 AVOCADO (*Persia americana* Mills.)

Climate

Avocados can be classified according to three ecotypes based on their climatic requirements: Guatemalan; Guatemalan x Mexican hybrids and 'West Indian' type. Commercially important subtropical cultivars (Guatemalan & Guatemalan x Mexican hybrids) are best grown under cool subtropical conditions, with mean daily temperatures of 20°C to 24°C. The mean monthly maximum temperature during the summer months should be less than 29°C. Light frost can be tolerated, except during flowering and fruit set. Humidity in excess of 50% at 14:00 is desirable, especially during flowering and fruit set, hence these avocadoes do well in mist-belt areas (Bio-Resource Group 5 - Moist Midlands Mistbelt (Fig. 1)).

The tropical lowland, "West Indian" types, are of little commercial importance except within a short distance from their production point. They prefer warmer, humid conditions and are best suited to the immediate coastal areas. They are sensitive to frost and tolerate a minimum temperature of 1.5℃. The optimum temperatures for growth are 25-28℃, with a RH exceeding 60%.

A well-distributed rainfall in excess of 1 000 mm is desirable (June and July may be dry).

Soils

Very important. Require free internal drainage to at least 1.2 m to prevent waterlogging and Phytophthora root rot. A higher water-holding capacity, implying a fairly high clay content, is desirable. A humic topsoil is desirable, with suitable soils including Inanda, Kranskop, Magwa, Hutton and Griffin soil forms.

Planting Times

During spring before the onset of high temperatures, but after the last frosts.

Bearing Age

First pick occurs at 2 to 4 years, with bearing extended up to 25 years.

Spacing

Varies according to cultivar and tree growth habit.

Traditional	6.5 m to 7.5 m x 6.5 m to 7.5 m.
High density plantings	3.5 m x 3.5 m.

Fertilization

Based on soil and leaf analysis (6-8 month old leaves, Feb to Apr). A general guide (g/tree/year):

Tree age (yrs)	N (g/tree)	P (g/tree)	K (g/tree)
1 – 3	40-120	20-60	75-220
4 – 5	170	95	300
6 – 7	225	125	400
8 – 9	280	160	500

Irrigation
Irrigation, particularly during the sensitive flowering period, is essential. An allowable moisture depletion of 30% due to the shallow root system. Crop factor = 0.65 (A pan)

Yields (t/ha)
Varies with cultivar, management and location. Alternate bearing is a problem.
Good average yields are:

Fuerte	8 to 10
Hass	12 to 15
Pinkerton	15 to 20

Pests
Various scale insects, thrips, mealybugs, fruit fly, false codling moth, tip wilters, stink bugs, coconut bug. Often not worth active control.

Diseases
Phytophthora trunk & root rot (NB), stem-end rot, pepper spot, sunblotch viroid, anthracnose and Cercospora spot.

Cultivars (Guatemalan or Guatemalan x Mexican hybrids)

Fuerte	-	May to November
Hass and Edranol	-	August to December
Pinkerton	-	July
Ryan	-	November to February

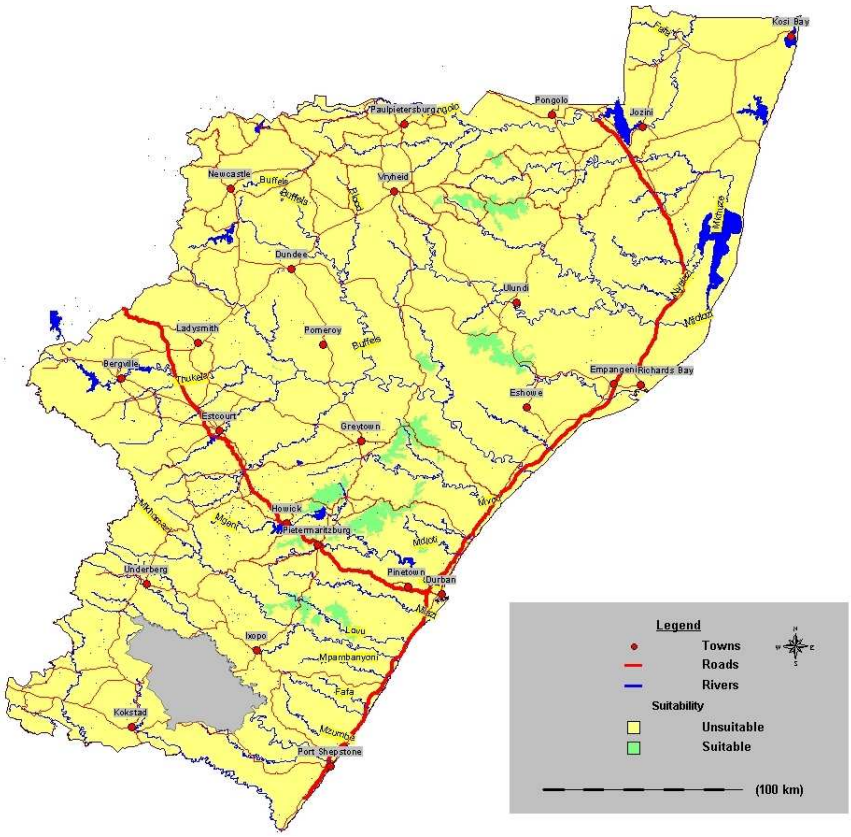

Figure 1: Climate suitability map for Guatemalan and hybrid avocado varieties.

1.2 BANANAS (*Musa acuminata*)

Climate

A tropical crop requiring a warm, humid, frost-free climate, with optimum temperatures between 22°C and 31°C. Growth ceases at temperatures above 38°C and below 14°C, with leaf chlorophyll destruction taking place at an actual temperature of 6°C (min July temperature >6°C), with leaf die-back at 0°C. These thresholds form a basis of estimating production potential and establishing limiting factors to banana production in different climatic regions. Thus, the humid low-lying coastal belt in north-eastern KwaZulu-Natal is the best suited to banana production, as well as the south coast (Port Edward to Port Shepstone). Best grown in BRG 1 (Moist Coast Forest, Thorn & Palm Veld)(Fig. 2).

A limitation in high-lying areas, or areas subject to temperature inversion, are cold winter temperatures that result in a virtual shut-down of growth and consequent choke-throat of winter-emerging bunches (so-called "November dump" bunches). These bunches are initiated (at ground level) during the cold winter period and are often deformed as a result of excessive cold during their initiation.

Soils

Well-drained to at least 1m, with a clay content of over 30–50%. Effective rooting depth (ERD) <0.75m.

Planting Material

Conventional suckers or bagged, rooted plantlets from tissue-cultured material. The latter is preferred as they are free of serious pests and diseases, and give higher yields from the plant crop, with some carry-over effect in the first ratoon crop.

Planting Times and Bearing Age

Early plantings (spring) tend to yield better than late plantings (autumn and winter). November to mid-February plantings will usually crop in autumn/winter, when higher prices prevail.

Plant to harvest, or harvest to harvest, time ranges from 13 to 20 months, depending mainly on prevailing temperatures and cultivar.

Spacing

'Williams'	3 x 1.75 m or 2.8 x 1.9 m (1 800-2000 plants/ha)
'Grand Nain'	3 x 1.5 m or 2.7 x 1.7 m (2 200 plants/ha)
'Chinese Cavendish'	2.5 x 1.6 m (2 500 plants/ha)

Fertilization

Based on soil and leaf analysis. Apply 40 g LAN (28) per plant every month from September to April and 200 g KCl per plant in September, November and February. This should be sufficient for a 40 t/ha crop. Apply evenly and not concentrated in a band around the plant. Lower rates would be used for lower yield expectations.

Irrigation

Ideally, bananas require at least 100-125 mm of water monthly, with no dry spells of longer than 7 days. Most production areas in S.A. would fall short of this requirement for at least 7 months of the year and it is therefore not surprising that irrigated bananas in KwaZulu-Natal out-yield dry land plantations by up to 50%. Irrigation is strongly recommended for successful production, even in the higher rainfall areas,

which have generally dry winters. Irrigate newly-planted tissue culture banana plants every day for 2 weeks (15 minutes per irrigation). For high clay soils apply 20 mm of water every 3 days in summer and every 8 days in winter. On light, sandy soil apply 12 mm water every 2 days in summer and every 5 days in winter (Anonymous, 2003).

Pruning Props & desuckering

Removal of old leaves important to prevent spread of foliar diseases. Surplus suckers must be removed regularly, to prevent them from competing directly with the follower sucker. Retain only one follower sucker which must be "marched" up slope or in direction of row. Props (wooden poles or twine) are important for support, especially in windy production areas

Yields (t/ha/annum)

Conservative : 20 to 25 Average : 25 to 30 Good : 40+

Pests

Slugs, thrips (especially banana flower thrip), mites, banana root borer, nematodes (particularly burrowing nematodes).

Diseases

Panama wilt is most important. Others include Armillaria, *Erwinia* corm rot, sigatoga, leaf and fruit spots, cigar-end rot.

Cultivars

Chinese Cavendish, Grand Nain and Williams are recommended. Dwarf Cavendish is also grown.

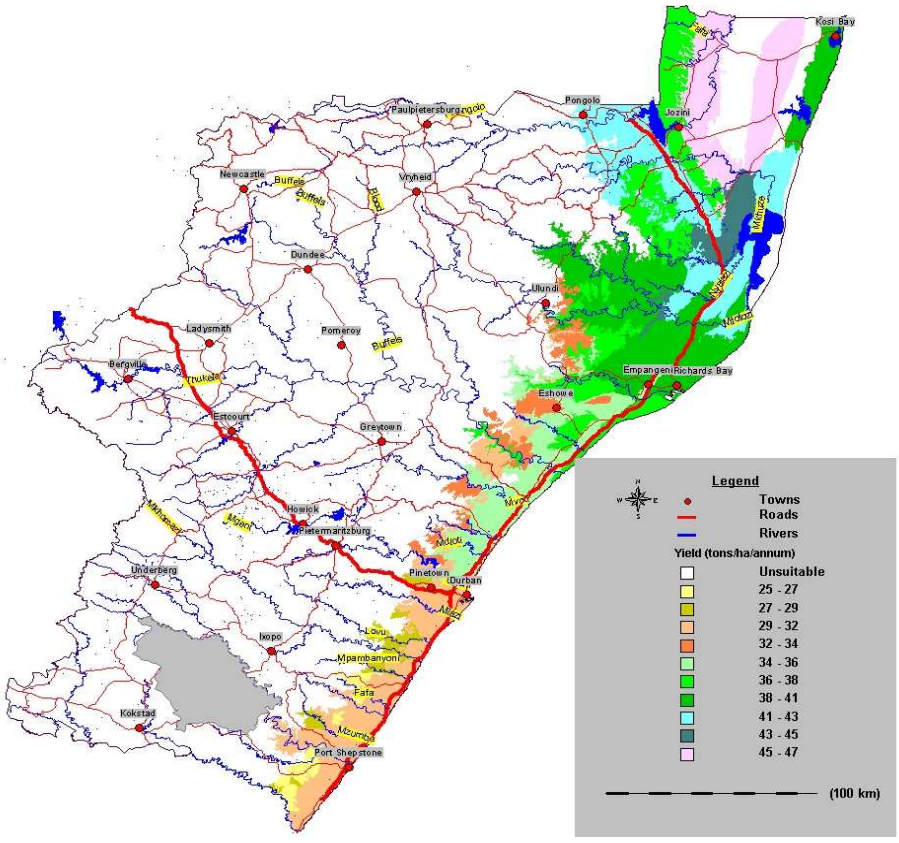

Figure 2: Climate suitability map for banana production in KZN.

1.3 CITRUS

Climate

Subtropical fruit, but can tolerate light frost. Cultivars vary in climatic requirements and each type should be looked at individually. Highest production is obtained in areas with a well-defined cold-induced dormancy period or moisture stress period.

Navel orange (Fig. 3)(low acidity) – Requires cool winters, minimum temperatures during 3 coldest months below 13^{o}C and maximum temperatures below 23.5^{o}C, as well as cool summer nights below 19^{o}C. Muden and Richmond are suitable areas.

Temperatures for optimal yields and quality:

T_{max} (Jun-Aug)	20.5 – 23.5℃
T_{max} (Nov-Dec)	25.5 – 28.5℃
T_{max} (Jan-Feb)	27.5 – 31.5℃
T_{min} (Oct-Nov)	9.5 – 14.5℃
T_{min} (Dec)	15.0 – 17.9℃
T_{avg} (Jun-Aug)	<13℃
Heat units (Base 13℃)	1600 to 1900 (Jan to Apr: 1 000 to 1250)

Valencia orange (Fig. 4) – Requires warmer and more humid areas than navels. Adaptable to different areas. Heat unit (HU) of 1 200 to 3 500 (wide tolerance). Suitable areas include Nkwaleni, Pongola and Mkhuze.

Temperatures for optimal yields and quality:

T_{max} (Jun-Aug)	19.5 – 30.0℃
T_{max} (Sept-Nov)	25.5 – 31.5℃
T_{max} (Dec-Feb)	27.5 – 33.0℃
T_{min} (Oct-Nov)	10.5 – 16.5℃
T_{min} (Dec-Jan)	14.5 – 17.0℃
T_{min} (Jun-July)	2.0 – 11.5℃
T_{avg} (Jun-Aug)	<12.0-16.0℃
Heat units (Base 13℃)	1200 to 3 500 (wide toleran ce)

Grapefruit (high acid fruit) (Fig. 5) – Base temperature 13℃. Grows well in hot ,humid low-lying regions. HU 2 900 to 4 550. Require warm humid climate with a short, warm winter. Suitable areas include coastal Zululand, e.g. Nkwaleni.

Lemons – Grow well in warmer areas. Adaptable to different areas. HU 1100 to 1500. Main crop in hotter areas produced in February to March, while crop in cooler areas produced during May to July.

Soft citrus/Mandarins – Base temperature 10^{o}C. HU 1 600 to 2 200 (Jan – Apr: 1 000 – 1 250).

Soils

Well-drained to 1m, with at least 500 mm of effective rooting depth. Ideally soils should have clay percentage less than 30%, but citrus is produced successfully on soils with widely divergent characteristics.

Planting Times

Optimum is early spring, but container-grown citrus can be planted at any time.

Spacing

Hot areas (Nkwaleni, Mkhuze)

Valencias 6.5-7.0 x 3.0-3.5m
Grapefruit 6.0-6.5 x 3.0m
Lemons 7.0-8.0 x 3.0-4.0
Cool/Cold areas (KZN Midlands)
Navels 5.5-6.0 x 3.0m
Valencias 5.5-6.0 x 2.5-3.0m
Lemons 5.5-6.0 x 2.5-3.0m
Mandarins 5.5-6.0 x 2.0-2.5m

Fertilization

Based on soil and leaf analysis (5-7 month old leaves, mid Mar-Mid Apr). During the first year, nitrogen may be applied every 2 months. Six applications of 25 g limestone ammonium nitrate (LAN) per tree per year. From the second year nitrogen must be applied twice a year, half in July and half in March. Fertilizer should be spread evenly under the canopy of the tree and irrigated. From the second year, nitrogen must be applied twice a year, half in July and half in March. Apply potassium at a rate of 50g per tree per year in early spring. Phosphorus may be applied at any time of the year. One application should be sufficient. No nitrogen or potassium must be applied at planting.

Fertilizer should be spread evenly under the canopy of the tree and irrigated. Very deep irrigations will wash the fertilizer down too deeply and out of reach of the shallow feeder roots.

Irrigation

Citrus trees require 75-100mm/month from July to March and 25-50mm per month from April to June. During the first 6 months the trees should be irrigated twice a week and thereafter every 7 days. Mature trees require 25m^3/tree/year.

Yields

	Valencias	Navels	Grapefruit	Lemons
First crop (years)	4	4	3	3
Expected lifespan (years)	32	32	18-23	23
Potential production:				
Mature trees (tons/ha)	60	45	65	65
Likely production	45-50	40	50	50
Conservative production	35	30	35	40

Pests

Red scale, thrips, mealybug, aphids, fruit fly, red spider mite, bollworm, psylla and leaf miners pests. Ants act as “protectors” of many citrus pests, against natural predators. Ant control (mechanical barriers, sticky strips, tree skirting) is an important means of promoting natural predators.

Diseases

Phytophthora root rot, blight, fruit diseases, viruses (tristeza, exocortis), greening disease.

Cultivars

A wide selection is available. The following will vary according to climate:

Grapefruit : Marsh, Nartia, Star Ruby
Navels : Bahianina, Palmer, Washington, Cara Cara

Midseasons	:	Tomango, Clanor, Shamouti
Valencias	:	Delta, Midknight, Kleinhans, Olinda, McClean, Amanzi
Lemons	:	Eureka, Lisbon
Soft citrus	:	Minneola, Satsuma (Owari, Miho Wase), Clementines (SRAs, Nules, Oroval)

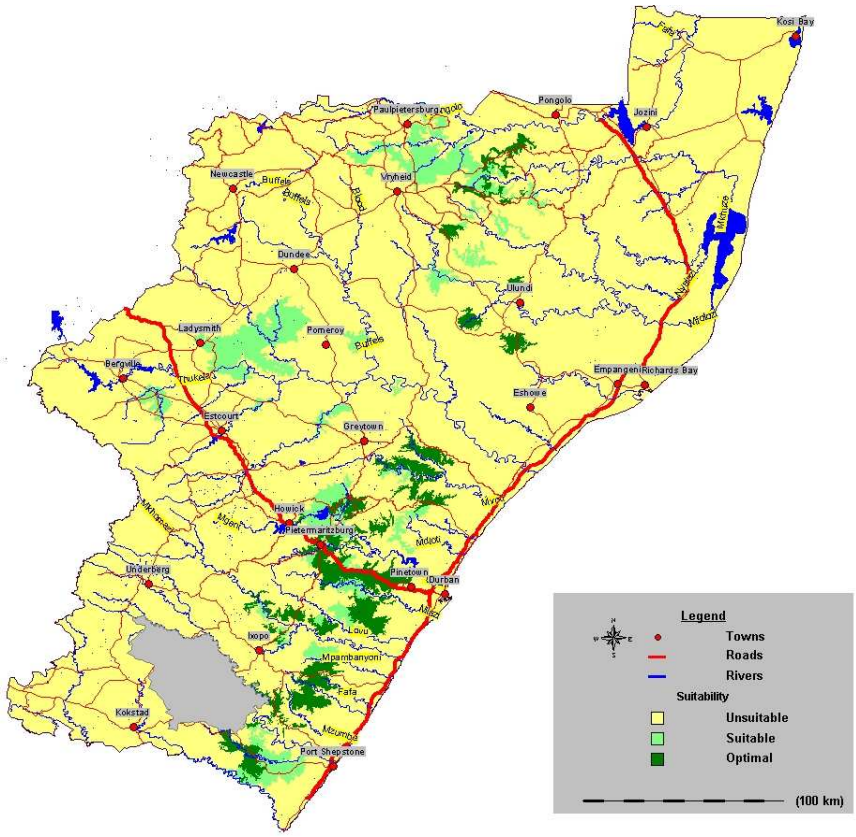

Figure 3: Climate suitability map for navel orange production in KZN.

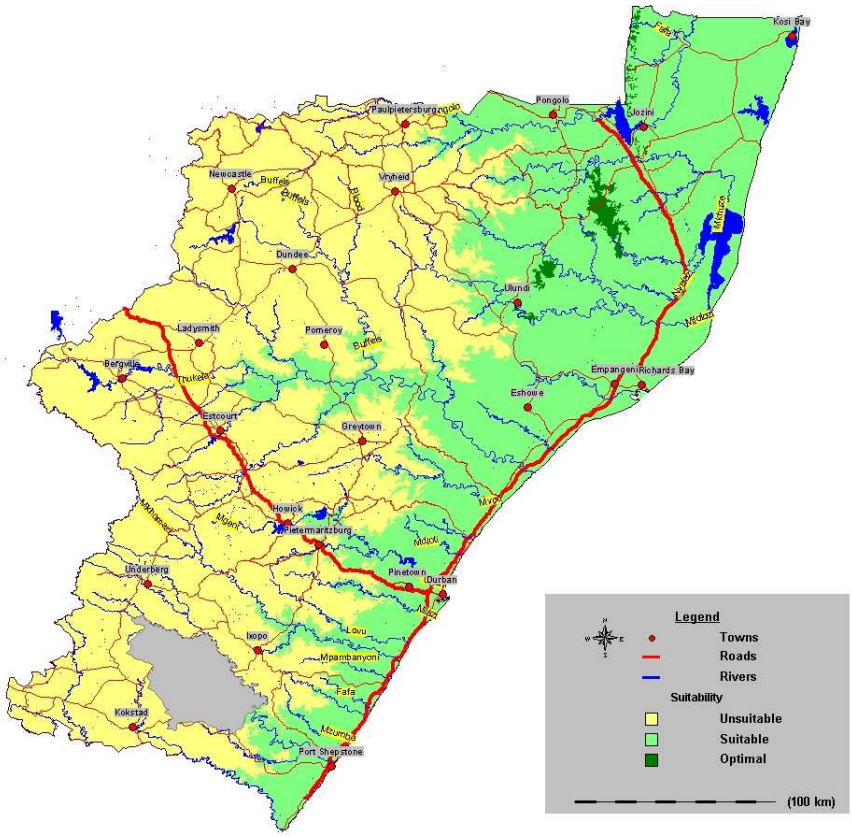

Figure 4: Climate suitability map for Valencia orange production in KZN.

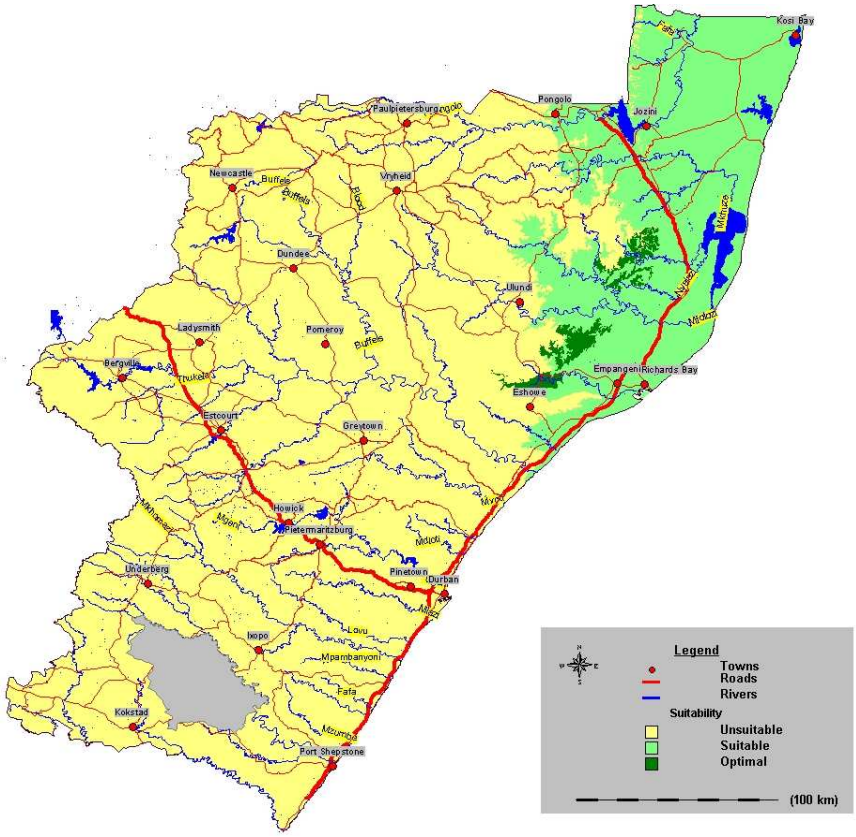

Figure 5: Climate suitability map for grapefruit production in KZN.

1.4 GRANADILLAS (*Passiflora edulis*)

Climate

Purple granadilla is the most widely grown and requires a cool, subtropical climate, moist and humid to sub-humid. Prefers a moderate temperature throughout the year, with high humidity during the hotter months. Average monthly maxima should not exceed 29^{o}C. The area should be frost-free, with average monthly minimums above 5^{o}C. Mature plants may withstand a few degrees of ground frost, but young seedlings are sensitive to frost. Windbreaks are essential in windy areas. Best grown in Bioresource Groups 3 (Moist Coast Hinterland) and 5 (Moist Midlands Mistbelt) on frost-free northern slopes (Fig. 6).

Yellow granadilla is very frost sensitive and has a higher heat unit requirement. Best grown in Bioresource Groups 20 (Dry Zululand Thornveld) and 21 (Valley Bushveld)(Fig. 6).

Soils

Soils should be well-drained and have a clay content of 10% to 40%, with no impermeable layers within the top 1m of the soil surface.

Planting Times

Seed is sown from spring to late summer and is transplanted when seedlings are 150 mm or higher. The average lifespan of a plantation is 3-4 years due to and soil-borne diseases.

Bearing Age

First harvests are obtained 6 to 8 months after transplanting, with full bearing within 18 months. Heaviest crop in November to January, secondary crop in June to July, with light cropping in between. In hotter, low-lying areas, the economic life is usually 3 to 4 years as a result of increasing incidence of soil-borne diseases (*Phytophthora* stem & root rot) and a complex of viruses. At cooler, higher altitudes plants may produce economic crops for up to 8 years.

Spacing

Rows 2,5 m to 3 m apart. Plants generally about 3 to 4 metres apart.

Fertilization

Must be based on soil and leaf analysis. Nitrogen should be applied monthly (28g/month) before flowering, followed by 28g N/vine as three dressings after flowering (July, Dec, Apr). Thereafter increase the three post-flowering applications to 42g N/vine. Apply half the potassium (75g KCl) and all the phosphate (150g single supers) in July-Aug and the rest of the potassium (75g KCl) in December. Zinc and boron deficiencies can be corrected with a foliar application of 200g zinc oxide/100L water and 100g solubor/100L water.

Irrigation

A good distribution of rainfall of 1000 to 1200mm/year is essential for commercial production. Plants require a maximum of 50m^3 /ha/day, or 15L/plant/day (3 300plants/ha), in summer and 25m^3 /ha/day, or 8L/plant/day, in winter. Granadillas are very susceptible to *Phytophthora* root rot and over-irrigation must be avoided.

Trellising & Pruning

Trellising is essential and pruning very strongly recommended. Use 12 gauge wire 2m above the ground. Plants pruned in July and cut back to 300mm from the main leader.

Yields (t/ha)
Conservative: 3 Average: 4 to 6 Good: 8+

Pests
Mealybugs, generally on the fruit stalks, and pumpkin flies, which affect the fruit.

Diseases
Phytophthora stem rots
Three virus diseases, of which woodiness is most important.

Cultivars
Purple granadilla, usually grown from seed.
Yellow granadilla gives good yields but is more acid and is grown for juice.

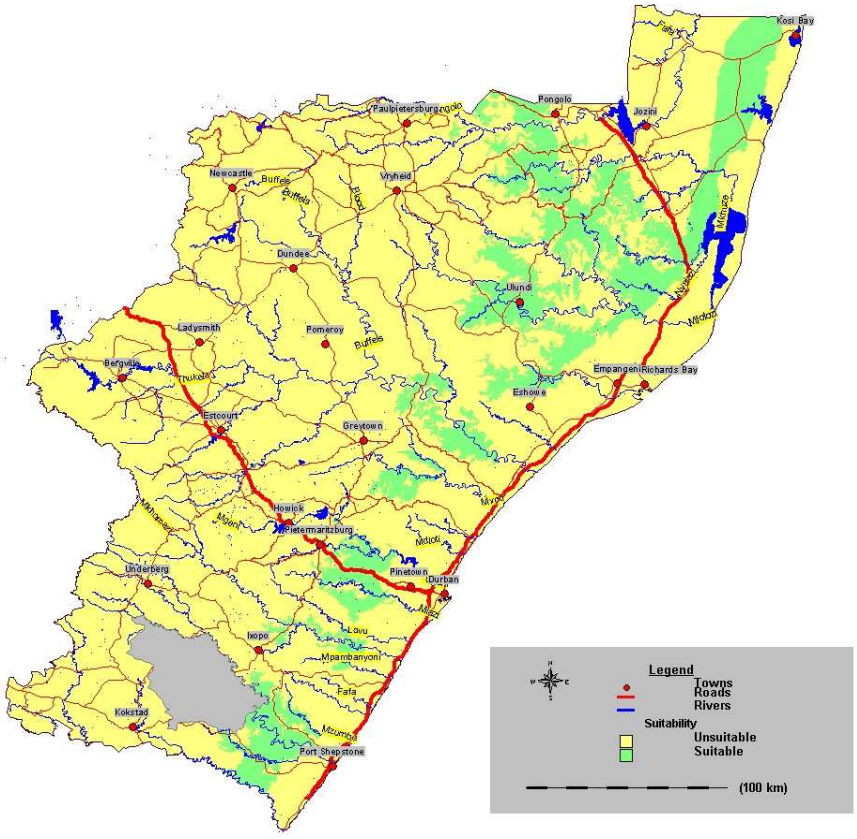

Figure 6: Climate suitability map for purple granadilla production in KZN.

1.5 LITCHI

Climate

Requires a warm to hot subtropical climate, moist and humid. Mean summer maximum temperatures should be between 27°C and 33°C, with average maximum temperatures of at least 23°C in October and 24°C in November. The average monthly minimum temperatures should be above 6°C, with no frost, but should preferably be below 14°C for the three coldest months to ensure the required dormancy with temperatures below 12°C being most conducive. The mean maximum temperature (June/July) should be <20°C for more consistent flowering. Relative humidity should be greater than 50% to prevent browning and cracking of fruit. Shelter against strong winds is advisable. Best grown in Bioresource Groups 1 (Moist Coast Forest, Thorn & Palm Veld), 20 (Dry Zululand Thornveld), 21 (Valley Bushveld) and 23 (Sandy Bush and Palm Veld)(Fig. 7).

Soils

Fairly adaptable to soil texture (10% to 40% clay). Requires a well-drained depth to at least 1 metre, preferably 2 metres.

Planting Times

Ideally in spring or at start of the rainy season.

Bearing Age

Cropping starts from about the fourth-fifth year. Trees are long-lived. Ripen in mid-summer.

Spacing

Traditionally 12 m x 12 m.
9 m x 6 m is finding favour (for better early production) where tree growth regulation and rejuvenation pruning is practised.

Fertilization

Based on soil and leaf analysis. General guide (g/tree/year):

Tree age (yrs)	N (g/tree)	P (g/tree)	K (g/tree)
1	50	25	25
2 – 3	150	25	50
4 – 5	300	25	100
6 – 7	400	50	150
8 – 9	550	50	200
10 – 11	700	75	250

Irrigation

The litchi has a high water requirement, needing rainfall of over 1000mm annually. Plants require a maximum of 44m^3 /ha/day, or 240L/plant/day (185plants/ha), in summer and 20m^3 /ha/day in winter. The trees are dormant in April to July, when irrigation should be reduced, especially in warmer areas (above 15°C), with usually no irrigation in June and July to induce flowering of bearing trees. Ensure, that young trees do not dry out.

Yields (t/ha)

Conservative: 2 Average: 3 to 5 Good: 6+

Pests
Nematodes, fruit flies, false codling moth and litchi moth larvae, with green stinkbugs attack ripening fruit. Fruit bats attack ripening fruit.

Diseases
Armillaria die-back

Cultivars
Mauritius, McLean's Red, Fay Zee Siu and Wai Chee – vegetatively propagated by means of air-layering and occasionally grafting/budding.

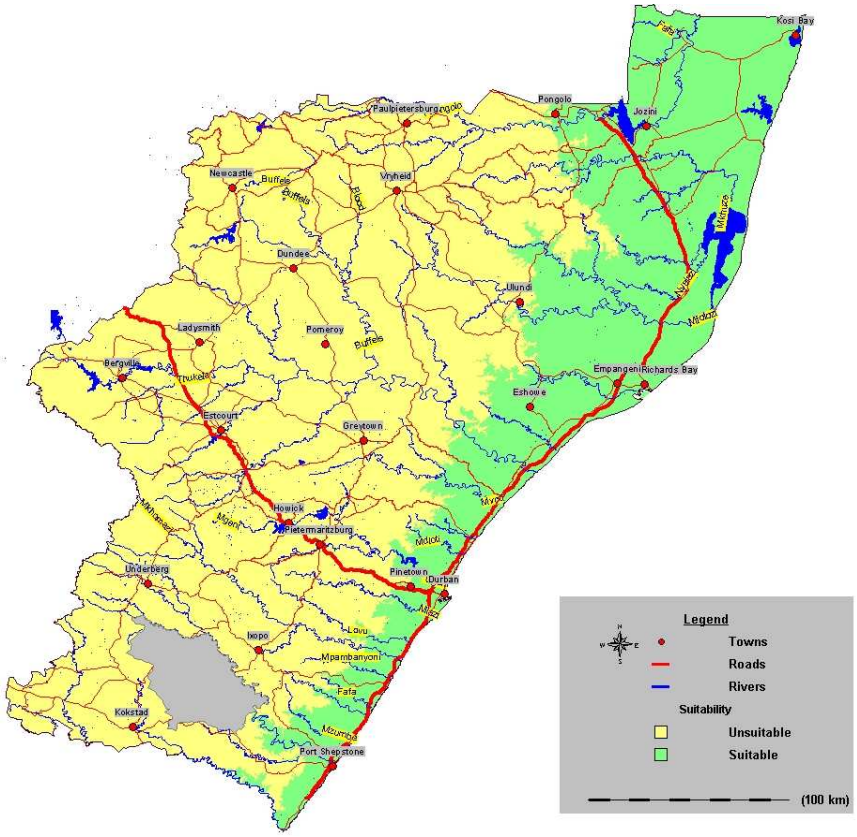

Figure 7: Climate suitability map for litchi production in KZN.

1.6 PAPAYA (Papaw)(*Carica papaya*)

Climate

This tropical plant has a high heat unit requirement and is sensitive to frost. Optimum temperatures range from 25°C to 28°C, with temperatures greater than 36°C and lower than 17°C adversely affecting cropping. Growth is retarded at temperatures below 12°C, with minimum June temperatures higher than 5°C. Although high humidity reduces the damage of sunburn, better quality crops are produced in drier areas under irrigation. Cool, but frost-free climates retard fruit development, but may extend the harvest into the high price period of late summer/autumn. Fruit development is hastened under hot conditions, allowing early fruits to mature during autumn. Heat units required from flowering to fruiting is about 2000 (Base temperature 12°C). Best grown in BRGs 21 (Valley Bushveld) and 23 (Sandy Bush and Palm Veld) with BRG 1 (Moist Coast Forest, Thorn & Palm Veld) being slightly less suitable (Fig. 8).

The papaya can be grouped into three basic sex forms:

Female: Trees bear pistillate flowers without stamens. The flowers generally have short pedicels and are borne in the axils of leaves.

Male: Trees bear predominantly staminate flowers without pistils. The flowers are stalkless and are borne in clusters on long compound spikes.

Hermaphrodite: Trees bear flowers with pistils and stamens. Up to eleven flower types can occur on one plant with the elongata flower being the most sort after.

The sex forms give rise to two types of commercial papayas. These are solo (or hermaphrodite) varieties eg. 'Sunrise Solo', and dioecious (Male and female flowers borne on separate plants) varieties eg. 'Honey Gold'.

Soils

A well-drained soil, with a minimum depth of 600 mm, and a clay content of 5% to 50% is acceptable, with 15% to 30% clay being ideal. Most roots responsible for nutrient uptake are located in the top 250mm. Hutton, Clovelly and Oakleaf are the most suitable soil forms.

Planting Material

Most papayas are grown from seed. Retain one male to every 15 to 20 female plants in the orchard. Certain selections ('Honey Gold') are propagated from cuttings raised in a mist-bed with bottom heating.

Bearing age

The first crop is generally produced about 18 months later, although this is shorter (9-11 months) under optimum conditions (Makhathini Flats), with annual cropping thereafter. The cropping season usually extends from about April to January, with a peak from September to November. The economic life of a plantation is only about 4-5 years.

Planting Times

Seed may be sown from spring to late summer. Sowing is best done in mid-summer.

Best time for planting is March/April as the first crop is harvested from more mature plants.

Spacing

3,0 to 3,5 m x 1.5 to 2,0m

Fertilization

According to soil and leaf analysis. Nitrogen is the most important factor for increasing papaya yields. Once established, apply 60g LAN/plant every six weeks during the first

year. Thereafter apply 120g LAN/plant every second month between September and April. Potassium should be applied pre-plant as well as 150g KCl/tree/year in the first year and 200g KCl/tree/year in the second year. Phosphorus must be applied pre-plant as well as an annual maintenance application of 450g Superphosphate in spring. Zinc and boron deficiencies can be corrected with a foliar application of 150g zinc oxide/100L water and a foliar application of 100g Solubor/100L water.

Irrigation

Papayas are relatively drought-tolerant, but will not achieve optimum yields without sufficient soil moisture. The following is a guide to papayas water requirements (O'Hare, 1994):

Time of year	Year 1 (L/plant/day)	Year 2 (L/plant/day)
autumn	6–13	9–17
winter	4– 9	6–13
spring	9–17	13–26
summer	13–26	17–34

Yields (t/ha)

Conservative: 10 to 15 Average: 20 to 25 Good: 30

Pests

Nematodes, aphids, fruit flies, bagrada bug, mouse-birds, monkeys.

Diseases

Damping-off, stem and root rots, powdery mildew, black spot, freckle, virus diseases, anthracnose.

Cultivars

'Honey Gold', Sunrise Solo, Sel 42 (Solo-type), Af-1, Baixinho, Tainung#2 & Red Lady.

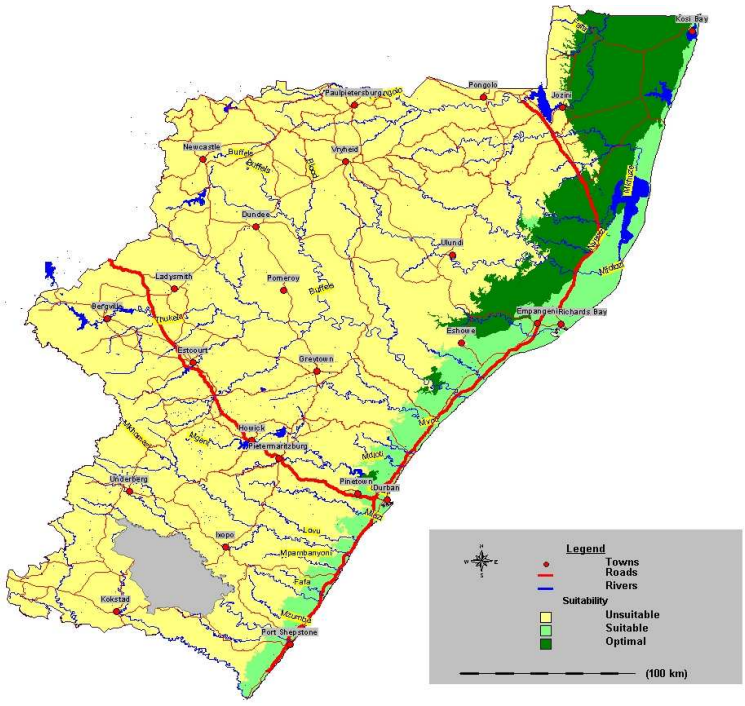

Figure 8: Climate suitability map for papaya production in KZN.

1.7 MANGO (*Mangifera indica*)

Climate

The tree grows well in tropical and warm sub-tropical areas. It cannot tolerate frost. Mean monthly minima in June/July must be above 8°C. Temperatures below 12°C adversely affect pollination. Temperatures above 36°C are harmful. Optimum temperatures are 20°C to 30°C, with a maximum summer temperature of 27-36°C. Mango flowers and young fruit are very sensitive to various fungal and bacterial diseases, which develop under moist conditions. The crop, therefore, does best in areas with low rainfall and low humidity during spring to early summer. Best areas for production are the frost-free areas of BRGs 20 (Dry Zululand Thornveld), 21 (Valley Bushveld) and 22 (Lowveld) (Fig. 9). RH should be below 55% from October to harvest. Rainfall should be ≤50mm (Sept), ≤85mm (Oct), ≤110mm (Nov) and ≤140mm (Dec to Feb). Best mango production at altitudes <600m above sea level.

Soils

Soil should be well-drained to a depth of 1 m for best results. A clay content of 15% to 30% is preferred, but up to 50% is acceptable. Most roots occur in the top 250mm. Hutton, Clovelly and Oakleaf are the most suitable soil forms.

Planting Material

All plants are vegetatively propagated by grafting, except for the cultivars Peach and Sabre, where the plants are raised from seed.

Planting Times

The best time for planting is in summer, from November to February, with early planting being preferred.

Bearing age

Grafted trees generally start bearing after 3 or 4 years, but can remain productive for 20 years or more.

Spacing

The traditional spacing was about 10 m x 8 m. As with other permanent fruit crops, high density spacings, with tree manipulation and possibly tree removal, is now advocated, with spacings varying from about 5 m X 2.5 m (Sensation) to 6 m x 3 m (other cultivars).

Fertilization

According to soil and leaf analysis. A general guide (g/tree/year):

Tree age (yrs)	N (g/tree)	P (g/tree)	K (g/tree)
1	70	25	200
2 – 3	140	50	200
4 – 5	210	75	250
6 – 7	280	100	375

Zinc and boron deficiencies can be corrected with a foliar application of 200g zinc oxide/100L water and a foliar application of 300g Solubor/100L water.

Irrigation

Plants require a maximum of 44m^3 /ha/day or 80L/plant/day (555plants/ha) in summer and 20m^3 /ha/day 36L/plant/day (555plants/ha) in winter. The trees are dormant in May to July, when irrigation should be reduced as some degree of water stress is

advantageous during flower bud development, with usually no irrigation in June and July for bearing trees. Ensure, however, that young ones trees do not dry out.

Yields (t/ha)
Conservative: 3 Average: 5 to 8 Good: 10 to 15.

Pests
Coconut bug, fruit flies, mango scale, mango weevil, mango bud mite.

Diseases
Bacterial black spot, anthracnose, powdery mildew.

Cultivars
Zill, Sensation, Kent, Keitt, Kensington, Neldica, Heidi, Tommy Atkins and Haden.

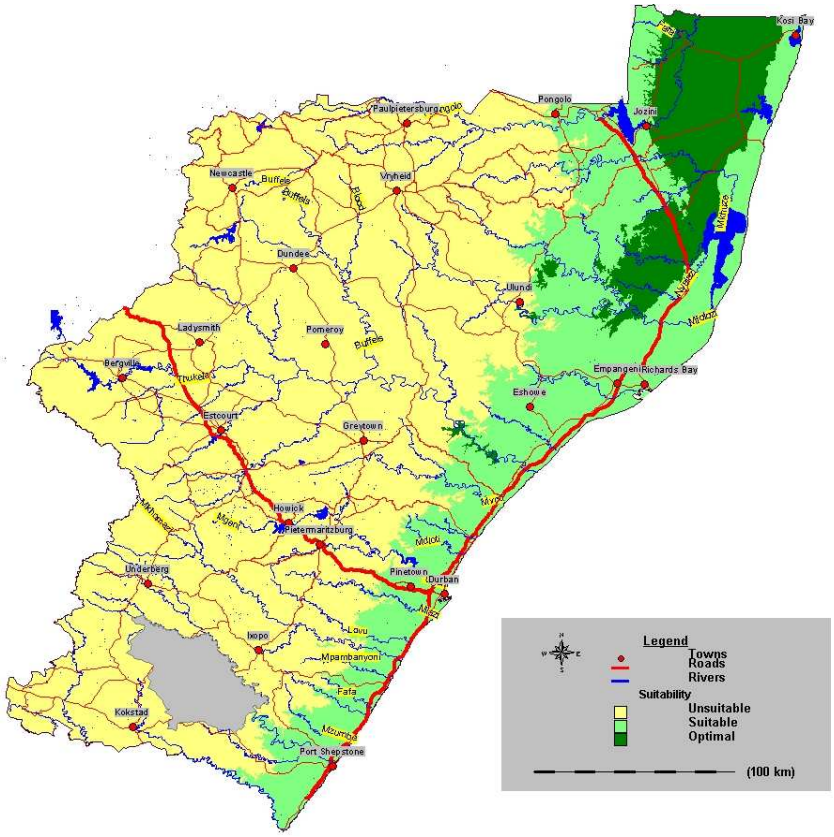

Figure 9: Climate suitability map for mango production in KZN.

1.8 PINEAPPLE (*Ananas comosus*)

Climate
This plant flourishes in a temperature range of 15°C to 30°C with 24°C being optimum for growth. Sunburn is a problem above 35°C. Growth is retarded when temperatures drop below 15°C, or exceed 30°C. Temperatures below 8°C induce black heart, a physiological disorder. Plants are frost sensitive. A high humidity yet low rainfall, is preferred; the high humidity reduces the danger of sunburn. Best areas for production are around Hluhluwe (Fig. 10).

Soils
Suitable soils range from light sands, such as Fernwood form, to heavy clay soils within the Shortland form. Good drainage is essential, so planting on ridges is practised extensively.

Planting Times
In the warmer production area of Hluhluwe there is year-round planting. In cooler areas planting is restricted to the warmer months, but the use of chemicals to control flower initiation enables almost year-round marketing. Planting material is limited.

Spacing and Planting Material
Cayenne – Generally in double rows. 990 x 533 x 305 mm (43 000 plants per hectare) is popular. The crown is the main propagating material.
Queen – Suckers planted at 120 000 to 150 000 plants per hectare tend to give optimum yields, but need to be re-established after the plant crop. Stumps are occasionally used.

Bearing Age
Can vary tremendously, but a cycle time of 18 months is normal at Hluhluwe.

Yields (t/ha)
Conservative: 50 Average: 60 to 75 Good: 80

Pests
Nematodes, mealybug, white grub, black maize beetle, pineapple scale, various mites.

Diseases
Phytophthora root rot and heartrot, black spot (especially in Queens) and leathery pocket. Sunburn and blackheart also cause problems.

Cultivars
Smooth Cayenne - mainly processing, weight 2kg
Queen - mainly fresh market, weight 0.75kg

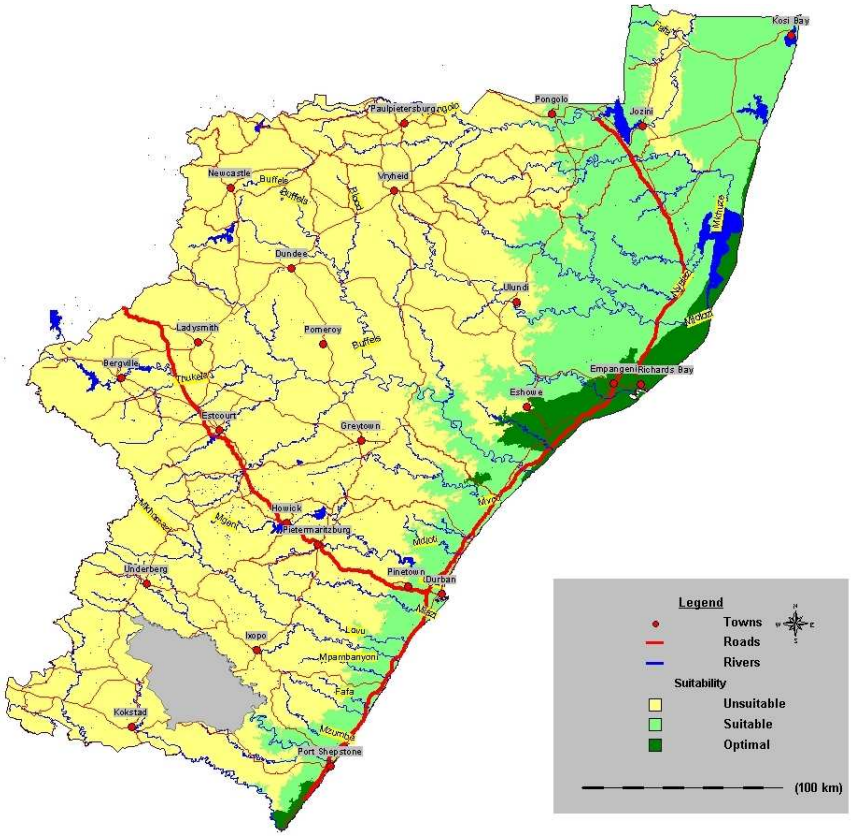

Figure 10: Climate suitability map for pineapple production in KZN.

2. NUTS

2.1 MACADAMIA (*Macadamia tetraphylla* and *M. integrifolia*)

Climate

Requires a warm to hot subtropical climate, but prefers a sub-humid area. Average monthly maximum temperatures up to 29°C, with average monthly minimum temperatures above 3°C, with mean temperatures between 16 and 25°C being ideal. Shelter against strong winds is desirable. Tolerates very light frosts; no growth at temperatures below 12°C. Best areas for production are BRGs 1 (Moist coast on higher slopes), frost-free areas of 19 (Moist Zululand Thornveld), 20 (Dry Zululand Thornveld), and 22 (Lowveld) (Fig. 11). Altitude influences nut quality and production. Production declines dramatically above 600m. Above 650m, growth is slower and trees take longer to bear.
Trees are susceptible to strong winds, due to narrow crotch angles and brittle wood.

Soils

Well-drained soils to a depth of 1 metre or more and a clay content between 10% and 40%.

Planting Times

Spring to late summer. Ideally at commencement of rain season.

Bearing Age

Bearing starts at 4 or 5 years, with full production in year 12. Trees are long-lived. Nuts ripen autumn/winter.

Spacing

	Initial Spacing	Final Spacing
Traditionally	10 m x 10 m	10 m x 10 m
High Density	10 m x 6 m	10 m x 12 m
	Prune and remove alternate trees when necessary	
High Density	7 m x 7 m	10 m x 10 m
	Prune and remove alternate diagonal trees when necessary.	

Fertilization

According to soil and leaf analysis. A general guide (g/tree/year):

Tree age (yrs)	N (g/tree)	P (g/tree)	K (g/tree)
1	56	21	40
2 – 3	100	25	70
4 – 5	150	30	125
6 – 7	175	45	225

Zinc, boron and copper deficiencies can be corrected with a foliar application of 200g zinc oxide/100L, 75g Solubor/100L and 200g copper oxychloride /100L water.

Irrigation

Minimum annual rainfall of 1000mm.

Table 1: Macadamia tree requirement (mm/month)(Du Plessis, 1993).

Tree age	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
5 yrs	29	24	21	14	9	9	9	16	20	24	27	29
10yrs	81	67	59	38	26	26	26	46	57	69	77	81

Yields (t/ha – Dry-in-shell)
Conservative: 1.5 Average: 2 to 3 Good: 4

Pests
Stinkbugs, green vegetable bug, nut borer and false codling moth larva.

Diseases
If orchard to be planted has had history of Phytophthora root rot, avoid macadamias. Another disease, branch dieback, is usually associated with mechanical damage.

Cultivars
Beaumont (695), Kau (344), Fuji (791), Pahala (788), Mauka (741), Makai (800), Keauhou (246), Purvis (294), Kakea (508), Nelmak 2, 816, 842, A4 and A16.

695, 294, 800 and 660 - Coastal areas - 90 to 300 m above sea level.
695, 741, 344 and 660 – Areas between 600 to 640m above sea level
887, 842, 834, A4, A16, 788 and 816 - Areas >700m above sea level

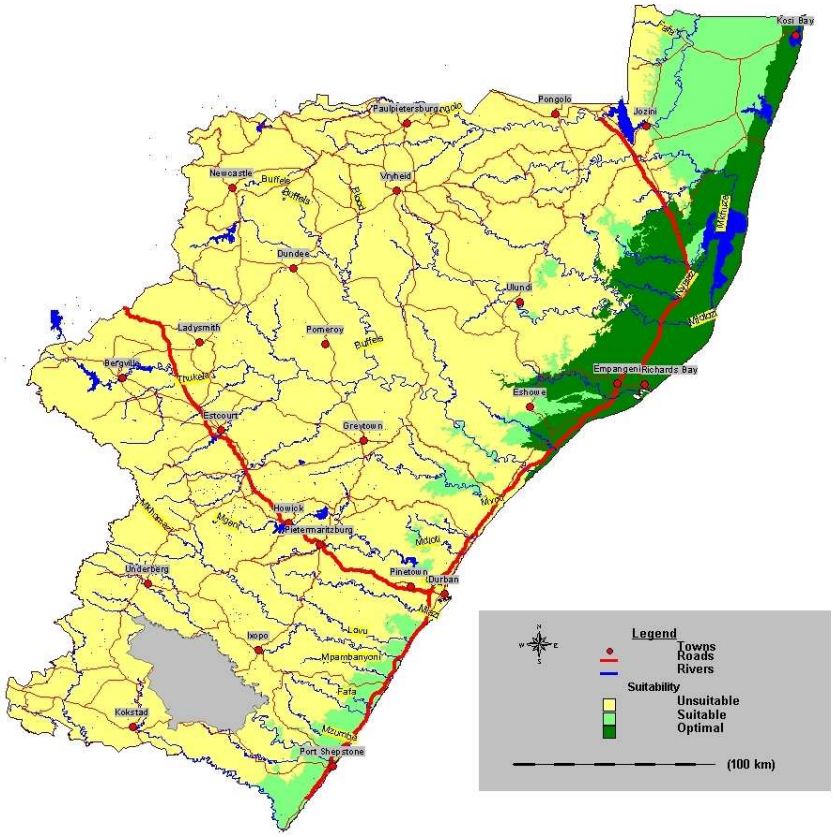

Figure 11: Climate suitability map for macadamia production in KZN.

2.2 PECAN NUTS (*Carya illinoensis*)

Climate

The pecan requires a continental climate, with hot summers and cold winters in moist to semi-arid areas, preferably grown under irrigation. Areas with short, cold winters and long, very hot summers are ideal. The average monthly maxima should be higher than 28°C in summer and lower than 23°C in winter. Heat units (Base temp 10°C) from October to April of 2700 to 3000. The average monthly minima during summer should be above 16°C but <8°C in winter. Mean monthly temperatures (Jun-Aug) of <13°C. Low temperatures and even frost during June to August are required. However, no frost should occur from mid-September to mid-May. Rainfall should be <700mm annually and humidity should be <55% during the greater part of the growing season, otherwise scab disease may be a major limiting factor. Best areas for production are the river valleys of BRGs 20 (Dry Zululand Thornveld) and 22 (Lowveld)(Fig. 12).

Soils

Fertile, very deep, well-drained soils with 10% to 35% clay are ideal. The taproot may penetrate to 8 metres or more. Soils should have a minimum depth of 3 metres. Suitable soil forms include Dundee, Oakleaf, Clovelly, Griffin and Hutton.

Planting Times

This deciduous tree must be planted when dormant, ideally in July.

Bearing Age

Light cropping starts at about 5 years, with full production in year 12-13. Trees are very long-lived.

Spacing

Generally planted 10 m x 10 m or 14 m x 14 m; prune and later remove alternate trees when their branches touch.

Fertilization

Annual application of fertilizers for pecan-nut trees – a general guide:

Application	**N (g/tree)**	**P (g/tree)**	**K (g/tree)**
g/tree/year	200	30	50
Maximum application: g/tree/year	1300	300	1000

Apply half the nitrogen (LAN) and all of the phosphate in August. Apply the remainder of the N and all the potassium in October. Pecans are very susceptible to zinc deficiencies and this element must be applied annually as a foliar spray of 200 g zinc oxide/100L water when the leaf buds are 50 mm long. Repeat at least 3 times at intervals of 2 to 3 weeks. It may be necessary in some cases to spray as many as 5 times. Many orchards are low in boron. The trees should be sprayed every 2 years with 100 g borax or 75 g Solubor /100L water.

Irrigation

Month	**Sept**	**Oct**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**
Amount (mm/month)	30	47	63	80	94	94	63

Yields (t/ha – Dry-in-Shell)

Conservative: 0.75 Average: 0.8 to 1.2 Good: 1.5 +

Pests
Nematodes, yellow pecan aphid, monkey beetles defoliate the young trees.
Long-horned beetles bore into the trunk of mature trees.

Diseases
Scab occurs mainly in wetter, high RH areas. Some cultivars are fairly tolerant.

Cultivars
Barton, Bester, Ukulinga – all tolerant to scab.
Choctaw and Shoshoni – less resistant to scab, but Shoshoni gives excellent yields in subtropical areas.

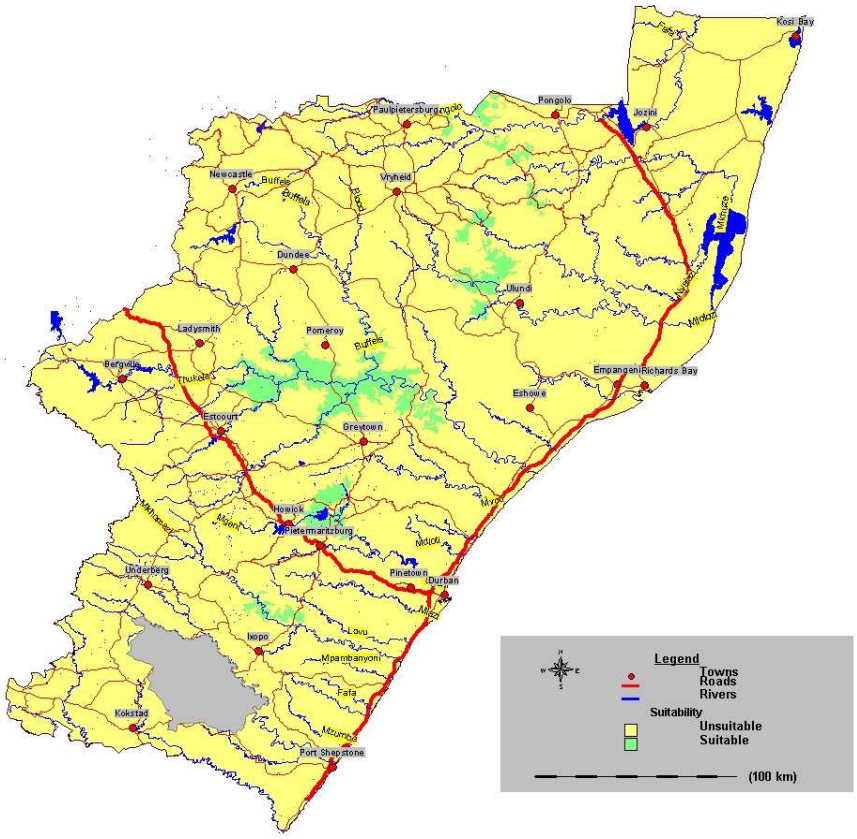

Figure 12: Climate suitability map for pecan nut production in KZN.

3. DECIDUOUS CROPS

3.1 PEACHES & NECTARINES (*Prunus persica*)

Climate

Peaches are temperate zone fruit, but grow best and develop better quality fruit in areas with warm summers. Trees flower early (late July) and require a cool, frost-free spring. Flowers can tolerate temperatures of -3°C, while small fruit can only tolerate temperatures of -1°C. Nectarines are particularly susceptible to cracking if heavy rains occur close to harvest. Low chill peaches and nectarines have a low chilling requirement and are thus best adapted to the drier river valleys of Muden, Middelrus and Weenen (Fig. 13). High chill peaches are best adapted to BRG 9 (Dry Highland Sourveld)(See apple map – Fig 15).

Soils

Peaches like deep, well-drained soils, with 10% to 35% clay are ideal. Suitable soil forms include Oakleaf, Clovelly, Griffin and Hutton.

Planting Times

Planted when dormant, ideally in July.

Bearing Age

Light cropping starts in year 3, with full production from year 7. Commercial orchards last approximately 12-15 years.

Spacing

Generally planted 6m x 4m or 5 m x 3 m; summer and winter pruning essential.

Fertilization

Leaf & soil samples must be taken during the last week of Jan/1st week of Feb. Annual application of fertilizers for peach trees – a general guide:

Tree age (yrs)	N (g/tree)	P (g/tree)	K (g/tree)
1	56	10	-
2	112	20	100
3	140	30	175
4+	Programme based on soil and leaf analysis results		

Nitrogen should be split into three applications, namely bud break to full bloom, 6 weeks after bud break and post-harvest. Apply half the potassium at budbreak and the rest post-harvest. Apply all phosphate in spring.

Irrigation

Trees should receive a “fill-up” irrigation in late April/early May of 50mm equivalent rainfall. Little irrigation required during winter. About two weeks before expected bud break, and after spring fertilizer application, apply 60-80mm. From full bloom to the end of harvest, 40-50mm of irrigation should be applied every 10-14 days. Once fruit have been harvested apply 50mm every 21 days up until the end of April.

Yields (t/ha)

Conservative: 12 Average: 15-18 Good: 25+

Pests

Nematodes, green peach aphid, scale, false codling moth, oriental fruit moth, fruit fly

Diseases
Leaf curl, brown rot, rust, freckle, gum spot

Cultivars
Low chill areas (200-600PCU's)
Peaches – Transvalia, Sonette, Oom Sarel, Keisie
Nectarines – Alpine, Mayglo, Fiesta Red, Armking
High chill areas (>600PCU's)
Peaches - Imperani, Impora, Rolees, Western Cling, Springcrest

3.2 SWEET CHERRY (*Prunus avium*)

Climate (Fig. 13)

Temperate fruits which require a cool, frost-free spring (best: 15-20℃ and 40-60% RH) and mild summer (<28 -30℃), and a cold, winter dor mant period. A warm, dry growing season is required to set and mature the fruit and a rain-free harvest period is necessary to avoid problems of fruit splitting. Winter chilling is vital to ensure enough chill units are received to break winter dormancy and thus allow growth to resume in spring. Daily Positive Utah Chill Unit (PCUs) model is based on work by Richardson *et al.* (1974), where temperatures are assigned chilling units, or portions thereof, for each hour at a given temperature. Cherries require in excess of 1000 PCUs between May and August for commercial production. Cherries flower during the first half of September and are thus particularly susceptible to late spring frosts which are a common occurrence in the various production areas. Low temperatures during spring also have a detrimental effect on bee activity, which is best between 17 & 22℃, but is dramatically reduced below 10-12℃.

Cherries have only been planted on a small-scale in KZN and trials are currently being conducted before it can be recommended as a viable commercial crop.

Soils

Ideal soils should be deep (0.8 – 1.0m), well-drained medium loams, with good water-holding capacity. Cherry rootstocks are very sensitive to poorly drained soils, which encourage the development of Phytophthora root rot, and do not tolerate wet conditions. Soil forms such as Hutton, Clovelly, Griffin and Oakleaf are the most suitable.

Spacing

Traditional spacing: 6 X 6m (278 trees/ha)
High-density spacing on dwarfing rootstock (Gisela 5): 4.5 x 2m (1 100 trees/ha)

Cultivars and Pollination

Most sweet cherries are self-incompatible, meaning they require cross pollination by a compatible variety for adequate pollination, fertilization and fruit set to occur. To ensure successful cross pollination, at least three to four compatible varieties should be planted with the pollenizors placed every 5th tree within the row.
Cultivars: Bing, Van, Rainier, Burlat, Vista,
Self fertile cultivars: Lapins, Stella, Sweetheart.
New low cultivars: Minnie Royal, Royal Lee, Royal Dawn, Early Sweet

Fertilization

Soil and leaf analysis must be done annually to monitor tree nutrient status and correct any deficiencies.
A general fertilizer programme for (Adapted from Zwahlen *et al*., 1989).

	N (g/tree)	**P (g/tree)**	**K (g/tree)**
Planting (1st year)	56	10	50
autumn	-	-	-
2nd year:			
Early spring	56	15	50
Autumn	-	-	-
3rd year:			
Early spring	56	15	50
Autumn	56	15	50
4th year onwards:	Programme based on soil and leaf analysis results		

Irrigation
Cherries require adequate irrigation, especially during the flowering and fruit ripening (September to November/December) to avoid plant water deficit which may reduce fruit growth rates and result in smaller fruit. Soil moisture levels should be maintained at between -20 to -35 kPa (tensiometer readings).

Yield
Yields for sweet cherries have been very difficult to predict due to difficulties experienced with pollination and fruit set. An average yield would be 4-6 kg/tree (4.5 to 6.5t/ha) in year 6, with a good yield of 9t/ha in year 8 or 9.

Pruning and training
Sweet cherries are generally trained into a modified central leader system. Cherries produce fruit at the base of 1-year-old shoots and on spurs formed on 2-year old branches and older.

Pollination
Plants are self-incompatible and require cross pollination to ensure good fruit set. Interplant pollenizors at a rate of 1:5. Beehives should be introduced into the orchards at 5-10% bloom.

Pests
Common pests include cherry slug, scale, thrips and bollworm.

Diseases
Bacterial canker, Phytophtora root rot, Shothole, crown gall (inoculation required at planting) and brown rot (fruit)

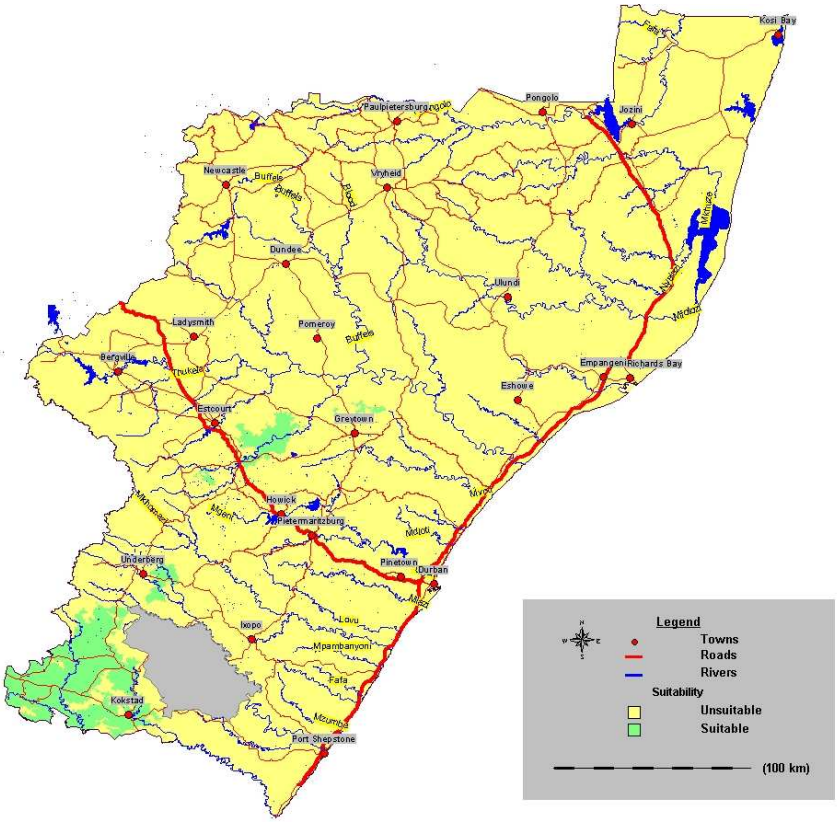

Figure 13: Climate suitability map for cherry production in KZN.

3.3 APPLES (*Malus domestica*)

Climate

Apples are temperate zone fruit which grow best in areas with cold winters and warm summers, within the latitude range of 25 to 52°. Flowers and young fruit can withstand temperatures of -2℃. Warmer climates often experience insufficient chilling which leads to poor bud break, delayed and prolonged flowering, which negatively impacts yields. The optimum temperature range for chilling accumulation is between 7.2 and 9.1℃. with temperatures >15℃ negating chilling. Rest-breaking agents (hydrogen cyanamide) are frequently used to overcome the lack of winter chilling. Best adapted to Dry Highland Sourveld areas (Fig. 14.)

Soils

Apples like deep, well-drained soils, with 10% to 35% clay are ideal. Suitable soil forms include Oakleaf, Clovelly, Griffin and Hutton.

Planting Times

Planted when dormant, ideally in July.

Bearing Age

Light cropping starts in year 3 and full production in year 7.

Spacing

Generally planted 6m x 4m or 4.5 m x 2 m; summer and winter pruning essential.

Fertilization

Leaf & soil samples must be taken during the last week of Jan/1st week of Feb. Annual application of fertilizers – a general guide:

Tree age (yrs)	N (g/tree)	P (g/tree)	K (g/tree)
1	48	20	-
2	100	20	50
3	150	30	100
4+	Programme based on soil and leaf analysis results		

Nitrogen should be split into three applications, namely budbreak to full bloom, 6 weeks after bud break and post-harvest. Apply half the potassium at budbreak and the rest post-harvest. Apply all phosphate in spring. Apply half the potassium in spring and the rest post-harvest. Zinc, manganese, boron and copper deficiencies can be corrected with a foliar application of 50g zinc oxide/100L, 200g/100L, $MnSO_4$, 100g Solubor/100L and 50g copper oxychloride/100L water.

Irrigation

Plants require 19 to 27m^3/ha/day, or 17L/plant/day to 25L/plant/day (1100plants/ha), from budbreak to pip hardening (75 days), 35m^3/ha/day, or 32L/plant/day, from pip hardening to harvest. Apply 5m^3/ha/day or 4.5L/plant/day during winter. The trees are dormant from May to August.

Yields (t/ha)

Conservative : 30 Average : 40-45 Good : 60+

Pollination
Plants are self incompatible and thus require cross pollination to ensure good fruit set. Interplant pollenizors at a rate of 1:10. Beehives should be introduced into the orchards at 5-10% bloom.

Pests
Bollworm, false codling moth, fruit fly, woolly apple aphid, red spider mite and aphids.

Diseases
Scab, powdery mildew, collar & crown rot.

Cultivars
Royal Gala, Fuji, Pink Lady®
Granny Smith, Golden Delicious - Pollenizors

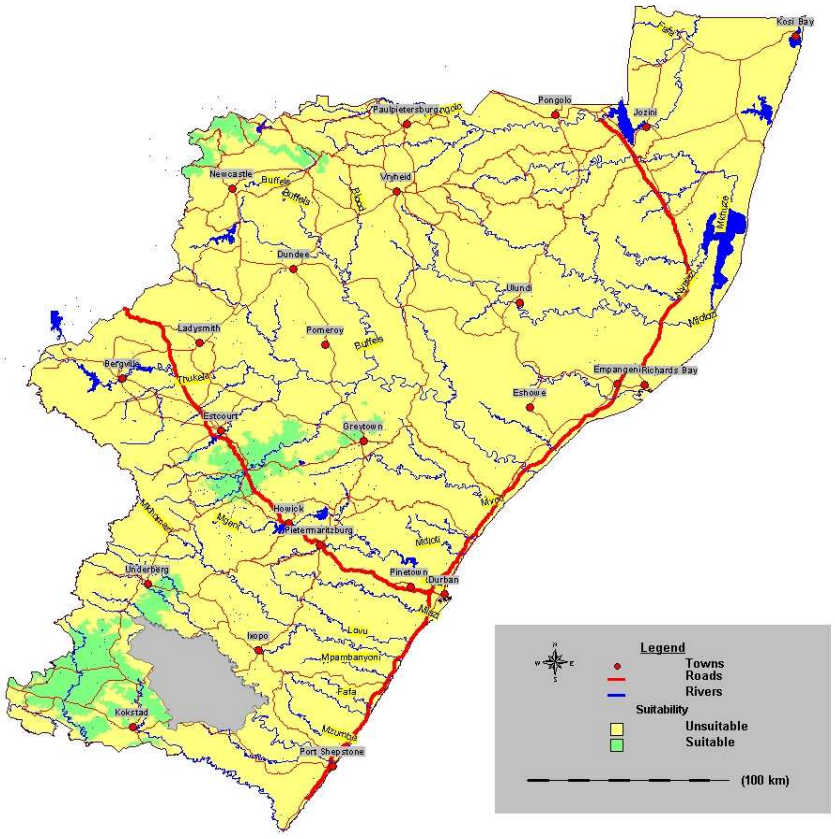

Figure 14: Climate suitability map for apple production in KZN.

4. BERRIES

4.1 STRAWBERRY

Climate

This perennial crop is generally treated as an annual or biennial. The plants are frost resistant, but flowers and fruit may be damaged. Plants become dormant when temperatures are low and days short.

A day temperature of 16^{o}C to 24^{o}C and a day-length of 10 to 12 hours are necessary for flowering. As day temperatures increase to 24^{o}C to 30^{o}C, and day-length to 14 to 16 hours, flowering ceases, vegetative growth becomes dominant and the plant produces runners and daughter plants. In autumn, when temperatures drop and days become short, runner production stops and the plant prepares for dormancy. Day-neutral cultivars, which have an extended harvesting season, are becoming popular in many countries.

In KwaZulu-Natal, flower and fruit production occurs in late autumn/winter in frost-free areas, in spring to early summer where light frosts occur and even into late summer in cold areas where average maximum day temperatures do not exceed 16^{o}C to 24^{o}C. In cold areas, autumn and winter flowers are eliminated by frost and production cannot commence until after the last frosts. North-facing slopes should be selected in these areas.

High rainfall, greater than 800 mm, results in poor fruit quality and more fruit disease problems, where rains occur during the harvesting season.

Soils

Warm, well-drained, sandy loams, with high organic matter, are ideal. Avoid soils with higher than 30% clay. Rooting depth should be 400 mm, but 200 mm can be acceptable. pH 5,0 to 6,0 is best.

Fertilization

A general fertilizer guide (Adapted from Vock, 1991) in g/1000 plants/month:

Season	**N (g)**	**K (g)**	**$MgSO_4$(g)**	**$CaNO_3$**
Winter	230-460	500-1000	10g/L (foliar)	3g/L (foliar)
Spring/ summer	460-920	500-1000	10g/L (foliar)	-

Apply all phosphate pre-plant (200-300kg/ha). Strawberries prefer high levels of organic matter, so a green manure should be grown in the land before planting and ploughed in by mid-December or apply 40 t/ha of kraal or poultry manure.

Irrigation

Strawberries are shallow-rooted and are thus very susceptible to water stress.
General guide to strawberry irrigation (Vock, 1991):

Type		**First two months after planting**	**Winter**	**Spring/Summer**
Overhead sprinkler	Amount/week	15-25mm	15-30mm	30-50mm
	Applications/week	2	1-2	2-4
Drip	Amount/week	3-4L	3-5L	6-10L
	Applications/week	2-3	1-2	3-5

Planting Times
Mid-March to late April, with early planting being favoured.

Spacing
Usually 300 mm x 300 mm to 400 mm in two, sometimes three or four, rows on raised beds, about 600 mm to 1 000 mm wide, with 500 mm paths between beds.

Cultivars
Selecta, Chandler. Strawberries are planted from runners. There is a shortage of planting material and a limited number of cultivars available.

Yields (t/ha)
Conservative : 10 Average : 15-20 Good: 30 +

Note:

1. Soil fumigation, especially for nematode control, is often advisable.
2. Planting on beds is suggested.
3. Mulching is strongly recommended.
4. Replant annually in most areas. In cold areas the crop may be retained for a second year, but yields and fruit quality are affected.

Pests
Nematodes, aphids, red spider mite, chafer beetle and weevil and caterpillars.

Diseases
Leaf spots, fruit rots (Botrytis and Anthracnose), virus diseases. Post-harvest handling of fruit is vital as fruit can form a rotten mass within a day.

4.2 RASPBERRY & BLACKBERRY (*Rubus* spp.)

Climate

Raspberries and erect and semi-erect blackberries are temperate plants which belong to the bramble fruits (*Rubus* spp.). The most obvious difference between a raspberry and a blackberry is that in a raspberry, the core remains on the bush when the "berry" is harvested, while in blackberries it comes off with the fruit and is part of the edible fruit. The canes of *Rubus* spp. are biennial, with the canes requiring an over-wintering period of sufficient length in order to initiate flowers. Bramble canes are typically vegetative in their first year of growth and are referred to as *primocanes*. These canes bear fruit the following year - during which they are called *floricanes*.
"Spring bearing" raspberries have a high chilling requirement similar to apples, while the "autumn bearers" have a low chilling requirement of 300-600 PCUs and are better suited to warmer subtropical areas (Fig. 15).

Soils

Well-drained, loam or sandy loams with high organic matter are ideal. Avoid soils with clay higher than 40%. Rooting depth should be at least 600 mm. pH 6.3 (H_2O) is best.

Spacing

Raspberries: 2.5-3.0m X 0.6-1.2m
Blackberries: 2.5-3.0m X 1.2-1.5m

Trellising & hailnet

Trellising required for all spring bearing cultivars to a double wire hedge row system while autumn bearers require support in windy areas. Hail netting is recommended for most production areas.

Fertilization

Based of soil and leaf analysis.

	Tree age (yrs)	N (kg/ha)	P (kg/ha)	K (kg/ha)
Spring bearer	1	90	20	90
	2	210	20	200
	3	300	20	250
	4+	Programme based on soil and leaf analysis results		
Autumn bearer	1	90	20	90
	2	150	20	200
	3	210	20	250

Zinc, boron and copper deficiencies can be corrected with a foliar application of 400g zinc oxide/100L, 100g Solubor/100L and 100g copper oxychloride/100L water.

Irrigation

Plants require approx. 30 000L /ha/week in spring and summer.

Planting Times

Plant in late July when vines are dormant.

Cultivars

Raspberries: "Spring bearers" - Glen Prosen, Glen Lyon, Tulameen
"Autumn bearers" – Heritage, Autumn Bliss
Blackberries: Lochness, Hull Thornless, Choctaw, Arapaho.

Availability of planting material is a limiting factor to production.

Yields (t/ha)
Conservative : 5 Average : 7-9 Good: 12+
Productive lifetime of 10-15 years. Budburst in spring. Flowering 3-4 weeks later, with fruit maturity & harvest 8 weeks later (1st week November to late January). Fruit has a very short shelf life (3-7 days) so distances from market are crucial.

Pests
Crickets, bollworm, antestia stinkbug.

Diseases
Downy mildew (dry-berry), anthracnose

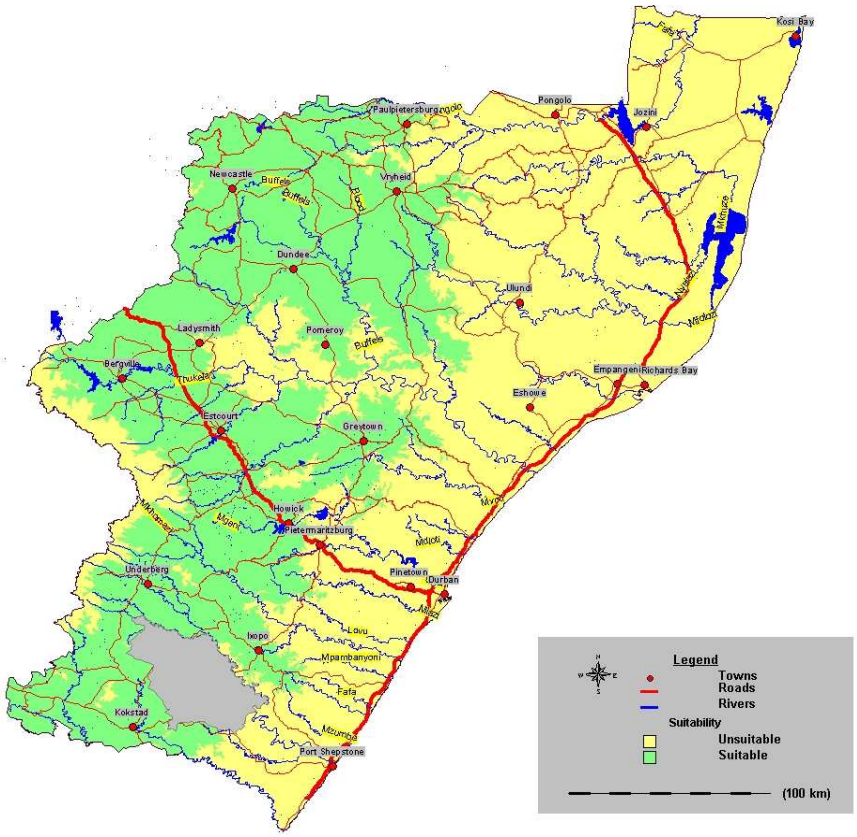

Figure 15: Climate suitability map for raspberry (autumn bearers) production in KZN.

4.3 **BLUEBERRY** (*Vaccinium* spp.)

Climate
Blueberries are temperate plants which require some winter chilling. The Highbush varieties (*V. australe*) have a high chilling requirement (Fig. 16), similar to apples, while the Rabbiteye varieties (*V. ashei*) have a low chilling requirement of 300-600 PCUs and are better suited to warmer subtropical areas (Fig. 19).

Soils
Well-drained loams, with high organic matter, are ideal. Rooting depth should be at least 600 mm. Acid soils are essential, with a pH 4.0 to 5.0 (KCl).

Spacing
3.0-4.0m X 0.75-1.0m (4444 plants/ha to 2500 plants/ha)

Pollination
Plant two or more compatible cultivars to ensure cross pollination and adequate fruit set. Beehives should be introduced into the orchards at 5-10% bloom.

Fertilization
Based of soil and leaf analysis.

Tree age (yrs)	N (g/plant)	P (g/plant)	K (g/plant)
1	14	10	20
2	28	50	30
3	35	20	40
4+	Programme based on soil and leaf analysis results		

Ammonium forms of N are preferred at pH >5.5. Apply half the N at budbreak and the rest 6 weeks later. Apply all P and K in spring. Iron and zinc deficiencies can be corrected with a foliar application of iron chelate (10% Fe)(200g/100L) and zinc oxide at 100g/100L water.

Irrigation
A uniform supply of moisture in the top 30cm of soil is essential for optimum growth. Plants require 170-270L/plant/month from September to November; 300-350L/plant/month from December to March; and 35-60L/plant/month in April/May.

Planting Times
Plant in early June to late August when plants are dormant.

Bearing age
Productive lifetime of 20-30 years. Time to full production: 6-7 years

Cultivars
Rabbiteye: Tifblue, Beckyblue, Climax. Limited planting material available.

Yields (t/ha)
Conservative: 4 Average: 6-7 Good: 10+

Pests
Stem borers, leaf rollers, mites & scale.

Diseases
Phytophthora root rot, Botrytis, anthracnose

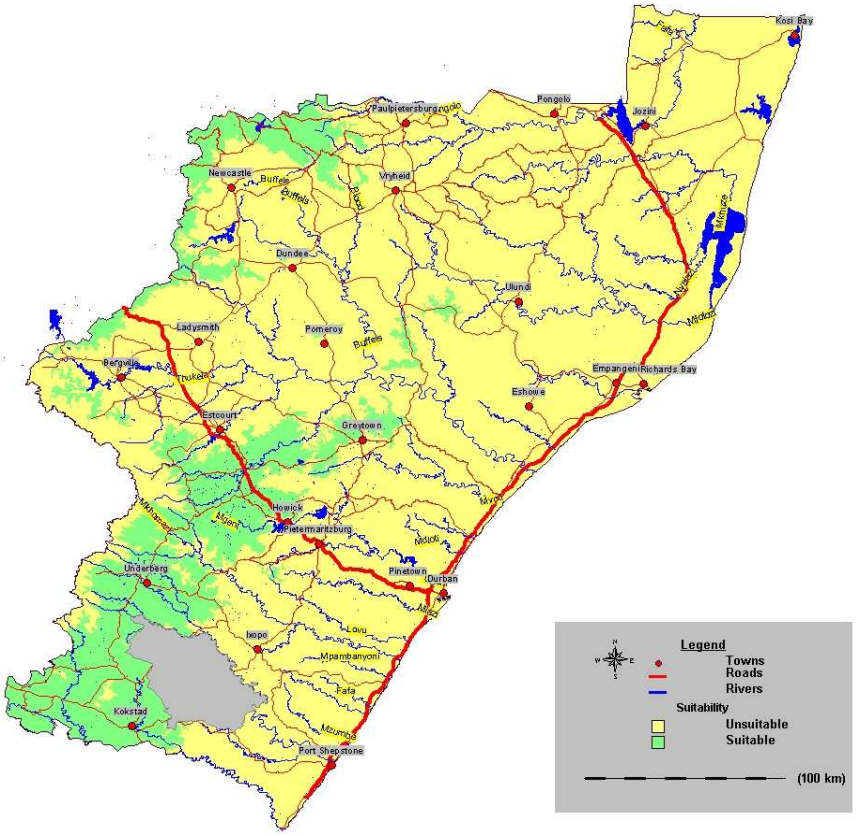

Figure 16: Climate suitability map for blueberry (Highbush) production in KZN.

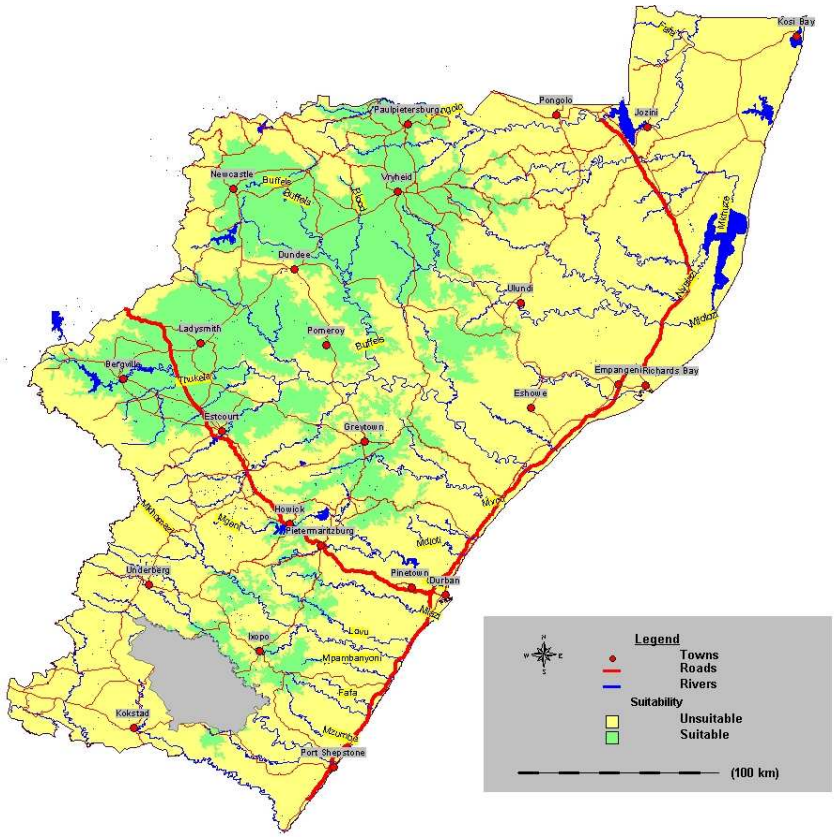

Figure 17: Climate suitability map for blueberry (Rabbiteye) production in KZN.

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