UNIVERSITY OF FORT HARE

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THE AGRICULTURAL POTENTIAL OF SCENERY PARK, EAST LONDON

THE AGRICULTURAL AND RURAL DEVELOPMENT RESEARCH INSTITUTE

UNIVERSITY OF FORT HARE

ALICE

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THE AGRICULTURAL POTENTIAL OF SCENERY PARK, EAST LONDON

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INTRODUCTION AND TERMS OF REFERENCE OF THE STUDY

Scenery Park is situated approximately 8 km, as the crow flies, from the sea and about 10 km upstream on the east bank of the Buffalo River. From the valley there are steep slopes up to the coastal plain on either side. The eastern extremity of the farm on this higher-lying ground has been developed and settled as a low income urban housing project. Nearby, to the north-east is the industrial area of Wilsonia.

Below Scenery Park the valley becomes very narrow and both slopes are covered by indigenous coastal forest much of it being part of Fort Grey Forest Reserve.

It is proposed by the developers that the area of Scenery Park situated in the Buffalo River Valley be developed as an urban agricultural project. To some people this must be viewed as a welcome development but for others it seems to be a sensitive issue. With the increasing human and livestock pressures all along the Buffalo River, many conservation-minded individuals would dearly hope that the remaining tracts of threatened indigenous vegetation would be spared for future generations.

On the other hand, with the rapid urbanization presently being experienced in South Africa, and no less in the vicinity of East London, there is a need for land for urban settlement. And since unemployment is likely to continue to be an issue in the future, some form of urban agriculture can be considered to be an appropriate form of land use.

During one of our early visits to Scenery Park a prominent member of the community asked us why it was necessary to conduct a survey of the agricultural potential of the area since it had been farmed in the past. This was a valid question, in a sense, yet also one which implied an element of expectation - that the area would once again be settled and farmed. Possibly it indicated also a lack of understanding of the complexity of the issue of appropriate land use.

The pack of hunting dogs at the rather desolate, yet inhabited, old farmstead on "area 2" of the farm, down in the valley, told another story. What are the dogs hunting? Is it bush pigs or other animals that damage the few crops that there might be, or do these dogs hunt game on the farm or in the neighbouring reserve? Is there a problem with vermin?

There are three areas or tracts of land that were obviously cultivated some time ago but have now largely been encroached by bush, mainly <u>Acacia.</u> How successful was the cropping?

While gathering information from the Agricultural Research Station we were told of the serious problems on the research station being experienced with theft. The nearby squatter camp was being blamed for some of the problems. Then driving back to Scenery Park along the Buffalo Pass one could but marvel at the breathtaking scenery looking across the Buffalo River Valley and the vastness, density and beautiful greenness of the coastal forest, of which there does not appear to be much left in the vicinity of East London.

Back at the Scenery Park urban settlement, one could appreciate the advantage for local inhabitants of being near the industrial area of Wilsonia and not very far from the city. The spokesman for the residents seemed very happy with developments to date, the prevailing peace and lack of crime in the area.

These observations are made in order to impress the importance of objectivity in developing settlements of any sort - particularly those involving sensitive issues. Our mandate is not to comment on these issues per se but to determine objectively and on the basis of scientific agricultural principles the agricultural potential of Scenery Park, bearing in mind however the proposed development of an urban agricultural project.

Our mandate included the following:

- To describe the vegetation of the area and comment on any threatened or endangered plant species that may exist on the farm.
- To conduct a soil survey with a view to determining the potential of three distinct areas (which we have termed Areas 1, 2 and 3) which had been demarcated as possible arable lands.
- To establish the potential of the different soil series on these lands for irrigated and dryland cropping.
- To estimate the water requirements for irrigation of crops on those soils that would be deemed suitable for irrigation.
- To investigate the physical and chemical properties of the soils and make recommendations for appropriate fertilizer practices.
- To analyse the water of the Buffalo river in terms of its suitability for irrigation.
- To identify potential field crops, vegetables and fruit crops that could be cultivated with success at Scenery Park.

There was no particular mention of livestock production although this could presumably also be an integral part of urban agriculture (although also a controversial issue).

The urgency with which the report had to be prepared, during a very busy period at the University of Fort Hare, precluded a more detailed survey of conditions and experiences on neighbouring farms and on the site itself. Nevertheless, we are confident that our report reflects the realities of the situation at Scenery Park and that it will enable the planners to decide on future developments, bearing in mind the sensitive ecology and priceless heritage that the area as a whole, although more specifically the indigenous forest, represents.

SECTION 1

1. VEGETATION OF SCENERY PARK

Scenery Park is situated in the Transitional Coastal Forest variation of Coastal Forest and Thornveld (Acocks 1988). Two vegetation types occur at Scenery Park: the forest community on the steep slopes of the Buffalo River and the thornveld community on the flatter areas.

The forest community is a dry forest and thus the trees seldom reach heights greater than 10 to 15m (Comins 1962; Robinson & Gibbs Russell 1980; Acocks 1988). Notable species that occur in the Buffalo River valley are Umtiza listerina (umtiza), Nuxia congesta, Buxus macowanii (Cape box) and Ptaeroxylon obliquum (sneezewood). Umtiza listerina occurs in few places outside the Buffalo River valley and is a protected species, while B. macowanii is limited to the Border coastal belt. The forest community is vulnerable to disturbance because of its occurrence on steep slopes in dry valleys. Once disturbed to the extent that extensive soil erosion occurs, the forest community may not recover. Few intact dry forests remain in the Border region because of the inability of this vegetation type to recover and thus this particular area should be conserved. A survey of rare plant species should be done in the forest community at Scenery Park.

The thornveld community consists of subtropical savanna vegetation with shrubs and small trees, usually in the form of bush clumps. Thornveld is widespread, contains no rare species and is more resilient than dry forest. Conservation of the thornveld community is therefore less important than conservation of the forest community, however utilisation of the thornveld community may have an impact on the forest community because of their juxtaposition.

SECTION 2

SOILS, LAND AND WATER

2.1 DATA COLLECTION AND PRESENTATION

An intensive soil survey of the three areas delineated on the base map was conducted. The boundaries of the soil units were established by means of field observations using a soil auger. The density of the field observations was approximately 1,2 per ha. The distribution of the soils in the areas surveyed is shown in Figures 2.1, 2.2, 2.3 and 2.4.

Six profiles pits were dug in representative soil units. Each of these profiles was described and sampled. The samples were analyzed in the Laboratory of the Department of Soil Science at Fort Hare. Profile descriptions and analytical results appear in Appendix A. The location of the profile pits is shown on the soil maps (Figure 2.1, 2.2, 2.3 and 2.4).

2.2 SOIL TYPES

The soils occurring in the area were classified according to the new South African soil classification system (Soil Classification Working Group, 1991). A total of six soil types were identified. These six soil types form the basis of the legend of the soil map. Where necessary, phases of a particular soil type were defined on the basis of rooting depth. Rooting depth is of paramount importance when assessing the suitability of a soil for irrigated or rainfed crop production. Mudstones, shales and in some instances sandstones form the parent material of all but one of the soil types.

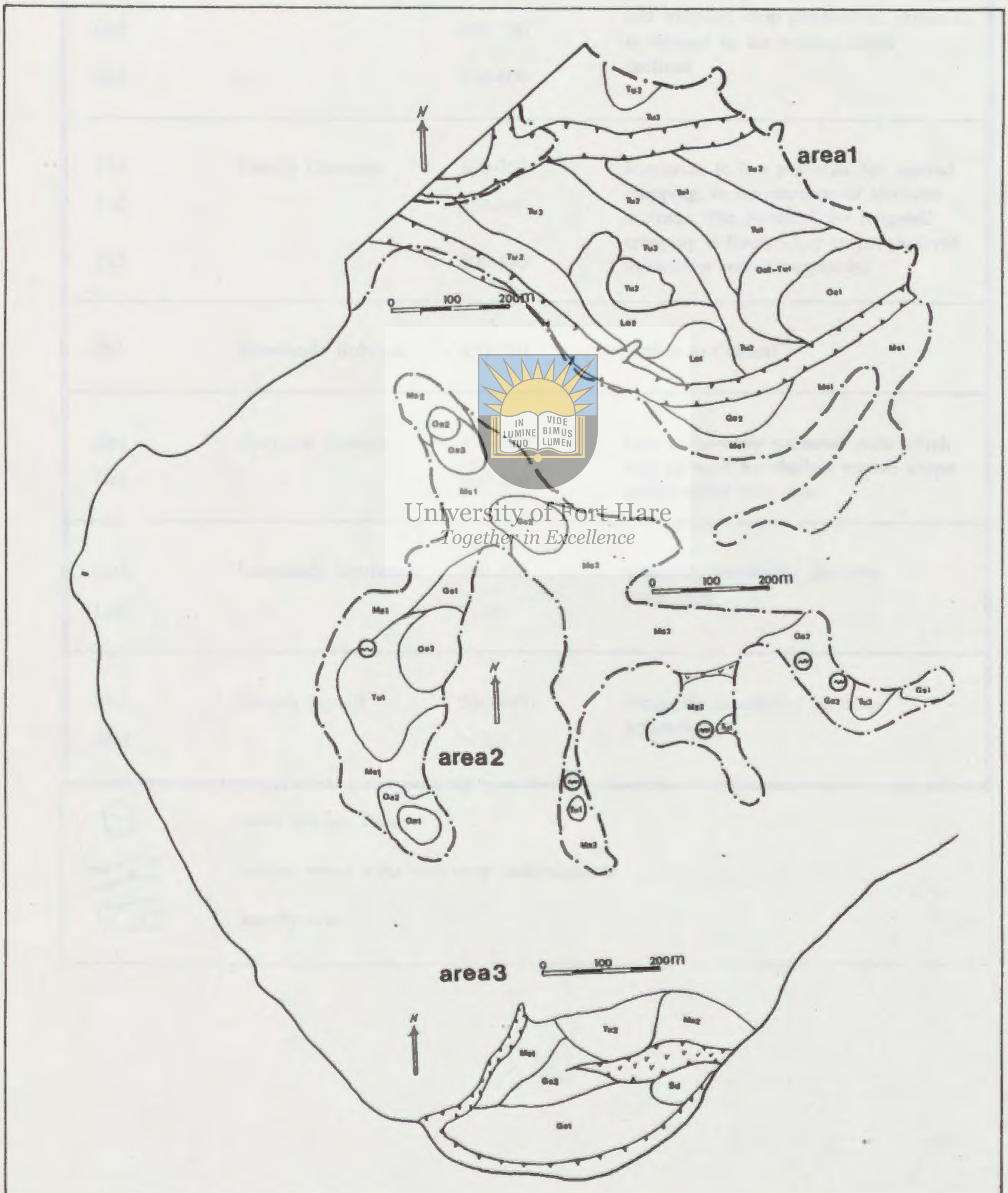
2.2.1 Oakleaf Buchuberg

This soil type covers approximately 6,2 ha. In Appendix A, profile 5, a description of a modal profile of the deep phase of this soil type is presented.

In the area surveyed, the rooting depth of the soils ranges from a maximum of 900 mm to a minimum of 450 mm, which is sub-optimal to marginal for most crops.

There being no signs of impaired drainage, even at the contact with the underlying rock, these soils are not expected to present drainage problems over extended periods of time, even under irrigated conditions.

Figure 2.1. Soils of Scenery Park.



LEGEND

Map symbol	Soil form and family	Rooting depth (mm)	Comments on the general suitability
Oa1 Oa2 Oa3	Oakleaf Buchuberg	750-900 600-750 450-600	Moderate to good potential for rainfed and irrigated crop production, potential is reduced as the rooting depth declines
Tu1 Tu2 Tu3	Tukulu Olivedale	600-750 450-600 300-450	Moderate to low potential for rainfed cropping; in the absence of artificial drainage, the potential for irrigated cropping is limited to hay crops, pastures or shallow rooted vegetables
Sh1	Shortlands Bolweni	450-750	similar to Oakleaf
Gs1 Gs2	Glenrosa Dumisa	450-600 300-450	Low to very low potential soils which may be used for shallow rooted crops grown under irrigation
Lo1 Lo2	Longlands Sherbrook	300-450 <300	Generally unsuitable for crop production
Ms1 Ms2	Mispah Myhill	250-400 <250	Generally unsuitable for crop production

 small storage dams

 natural water ways with steep embankments

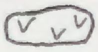
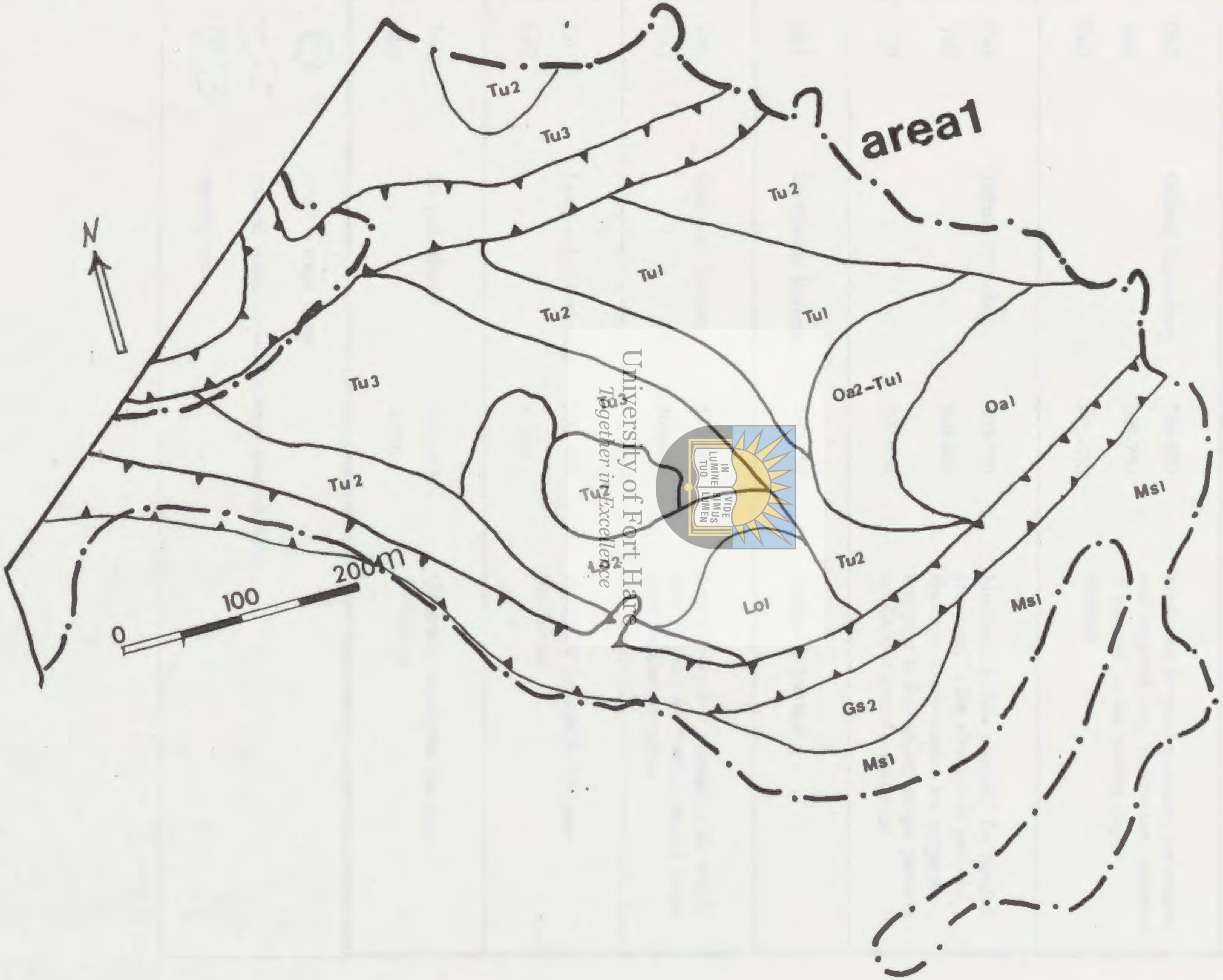
 marshy area

Figure 2.2. Soils of area 1.



LEGEND

Map symbol	Soil form and family	Rooting depth (mm)	Comments on the general suitability
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Sh1	Shortlands Bolweni	450-750	similar to Oakleaf
Gs1 Gs2	Glenrosa Dumisa	450-600 300-450	Low to very low potential soils which may be used for shallow rooted crops grown under irrigation
Lo1 Lo2	Longlands Sherbrook	300-450 < 300	Generally unsuitable for crop production
Ms1 Ms2	Mispah Myhill	250-400 < 250	Generally unsuitable for crop production


small storage dams


natural water ways with steep embankments

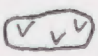

marshy area

Figure 2.3. Soils of area 2.

LEGEND

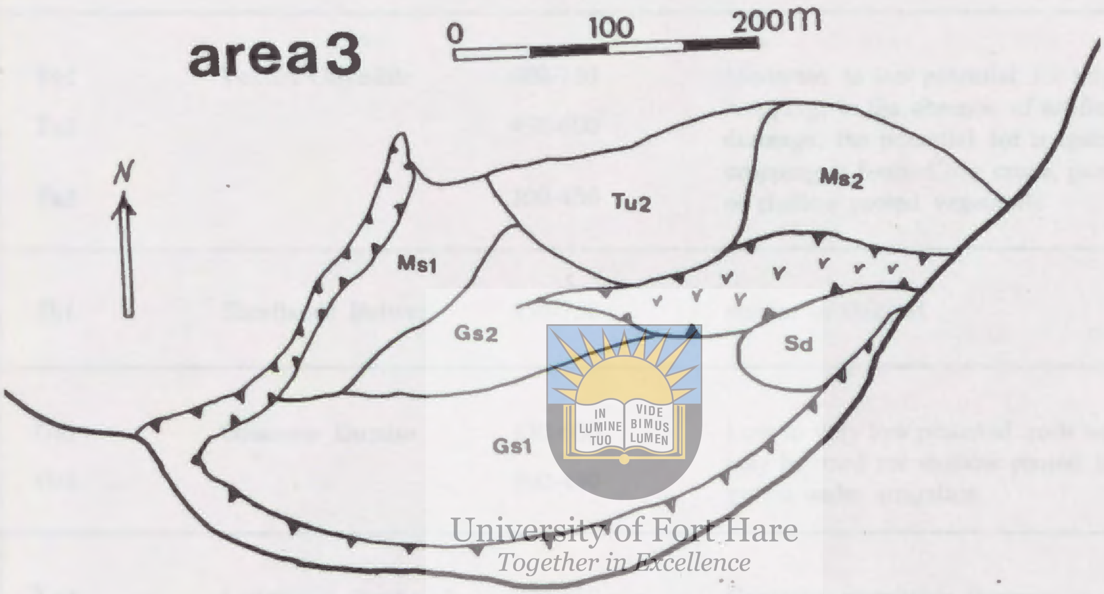
Map symbol	Soil form and family	Rooting depth (mm)	Comments on the general suitability
Oa1	Oakleaf Buchuberg	750-900	Moderate to good potential for rainfed and irrigated crop production, potential is reduced as the rooting depth declines
Oa2		600-750	
Oa3		450-600	
Tu1	Tukulu Olivedale	600-750	Moderate to low potential for rainfed cropping; in the absence of artificial drainage, the potential for irrigated cropping is limited to hay crops, pastures or shallow rooted vegetables
Tu2		450-600	
Tu3		300-450	
Sh1	Shortlands Bolweni	450-750	similar to Oakleaf
Gs1	Glenrosa Dumisa	450-600	Low to very low potential soils which may be used for shallow rooted crops grown under irrigation
Gs2		300-450	
Lo1	Longlands Sherbrook	300-450	Generally unsuitable for crop production
Lo2		<300	
Ms1	Mispah Myhill	250-400	Generally unsuitable for crop production
Ms2		<250	

small storage dams

natural water ways with steep embankments

marshy area

Figure 2.4. Soils of area 3.

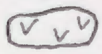


LEGEND

Map symbol	Soil form and family	Rooting depth (mm)	Comments on the general suitability
Oa1	Oakleaf Buchuberg	750-900	Moderate to good potential for rainfed and irrigated crop production, potential is reduced as the rooting depth declines
Oa2		600-750	
Oa3		450-600	
Tu1	Tukulu Olivedale	600-750	Moderate to low potential for rainfed cropping; in the absence of artificial drainage, the potential for irrigated cropping is limited to hay crops, pastures or shallow rooted vegetables
Tu2		450-600	
Tu3		300-450	
Sh1	Shortlands Bolweni	450-750	similar to Oakleaf
Gs1	Glenrosa Dumisa	450-600	Low to very low potential soils which may be used for shallow rooted crops grown under irrigation
Gs2		300-450	
Lo1	Longlands Sherbrook	300-450	Generally unsuitable for crop production
Lo2		<300	
Ms1	Mispah Myhill	250-400	Generally unsuitable for crop production
Ms2		<250	

 small storage dams

 natural water ways with steep embankments

 marshy area

In most cases, the texture of the top soil is silt loam and a gradual increase in the clay content with depth is typical. When cultivated, the surface horizon is expected to become prone to crusting or capping because of the high silt and fine sand content. Crusting causes a reduction in the infiltration rate and may hamper the emergence of crops with delicate seedlings, such as sunflowers.

The deterioration of the physical condition of the surface layer of these soils can be controlled by introducing an appropriate crop rotation programme. Such a programme should incorporate the planting of a perennial grass or a cover crop such as lucerne, which, after a number of years, improves the physical condition of the soil by elevating the organic matter content.

Generally, this type of soil presents few limitations with respect to crop production, be it under rainfed or irrigated conditions. However, a maximum rooting depth of 900 mm cannot be considered optimal. Therefore, the potential for dryland and irrigated cropping of deepest phase of this soil is rated moderate to high, only. The suitability of the shallower phases is obviously less than that of the deepest phase.

2.2.2 Tukulu Olivedale

This is one of the major soil types occurring in the area, covering a total of 20.5 ha. Two modal profiles of Tukulu Olivedale soils are presented in Appendix A, i.e. profile 1 and 6.

The properties of this soil type are similar to those of the Oakleaf Buchuberg soils, except for the occurrence of signs of wetness in the lower parts of the profile. These signs of wetness include grey colours, iron-manganese concretions and high chroma mottles. They indicate a reduction in the hydraulic conductivity near the bottom of the profile causing excess water to accumulate. In the case of the local Tukulu soils, the reduction in hydraulic conductivity is caused by an increase in the clay content near the boundary of soil and weathering rock or by the presence of parent rock with a very low permeability.

Under rainfed conditions, drainage problems will occur only when rainfall is abundant. However, when the soils are irrigated waterlogging may become a permanent feature. Artificial drainage may be required unless irrigation water is applied judiciously and with care. In this regard, hay crops and pastures are more forgiving than row crops such as maize and vegetables.

Because of the impaired drainage, these soils should be considered marginal to very marginal for irrigated cropping. The potential for rainfed cropping is slightly better. The Tukulu Olivedale soils will produce best when planted to hay or pastures.

2.2.3 Shortlands Bolweni

The occurrence of this soil type is limited to area 3 and its extent is limited to less than 0,5 ha. The presence of the Shortlands soil is associated with a very narrow dolerite dyke, which cuts through the sedimentary rocks which form the main parent material in the area. Because of the limited extent of this soil type little attention is given to its characteristics. Suffice it to say that it is a good soil, which is well suited for both irrigated and rainfed cropping. It is a pity not more of this soil was found.

2.2.4 Glenrosa Dumisa

A total of 9,1 ha is covered with Glenrosa Dumisa type soils. Two modal profiles appear in Appendix A, namely profile 3 and 4.

These soils consist of a surface horizon of variable depth, which merges into the underlying rock via soil tongues. These soil tongues are generally enriched in clay and are referred to as a Lithocutanic B horizon. The texture of these soils is similar to that of the Oakleaf soils, except in area 3, where the texture is coarser, i.e more sand and less silt and clay (see also analytical data of profiles 3 and 4 in Appendix A).

Where the surface horizon is relatively deep, the soils can be used for crop production, but their potential remains quite marginal. If there is an urgent need to take land into cultivation, it is suggested that only the deepest phase of the Glenrosa soils are considered.

2.2.5 Longlands Sherbrook

These soils are found in area 1 only, where they cover about 3 ha.

The local Longlands soils are developed in a shallow sandy deposit, thought to be a kind of an old aeolian (dune) deposit. Invariably, the bottom of the soil profile shows distinct signs of waterlogging in the form of a soft plinthic B horizon, which forms the transition between the sand and the underlying weathering rock. These soils are extremely poor and unsuitable for crop production. It is strongly recommended that these soils remain under natural vegetation.

2.2.6 Mispah Myhill

With an extent of 25 ha, Mispah Myhill is the main soil type in the area, especially in area 2. A profile description of a Mispah is presented in Appendix A profile 2, but this profile is not considered to be completely representative, because it is slightly less grey in colour and tends to be deeper than the more typical Mispah soils found elsewhere in the area.

Generally, Mispah soils consist of a shallow surface horizon which directly overlies the parent rock. Often the surface horizon is stony. The texture of the surface horizon is similar to that of the Oakleaf and Glenrosa type soils, namely silt loam.

The shallowness of the Mispah soils prohibits cultivation except in exceptional cases when the value of the proposed crop warrants the land to be ridged, thereby increasing the rooting depth of parts of the land.

2.3 GENERAL SOIL FERTILITY AND FERTILIZER RECOMMENDATIONS

In order to determine the general fertility of the surface horizon, the upper 15 cm of soil was sampled in a number of randomly selected places in each of the three areas. The analytical results are preaented in Table 2.1.

Table 1. The average nutrient content of the surface soils in the three areas.

Area	pH in water	Calcium (ppm)	Magnesium (ppm)	Potassium (ppm)	Phosphorus (ppm)
area 1	6,6	1 407	401	104	2
area 2					
-south western branch	7,3	[illegible]	[illegible]	167	21
-rest	6,5	1 785	427	182	12
area 3	6,9	637	380	91	2

The analytical results indicate that pH and calcium and magnesium contents are optimum and no liming is required. Test values for potassium are slightly lower than optimum, but crops are not expected to respond to potassium during the first few years of production. The phosphorus test values indicate severe deficiencies in area 1 and 3 and moderate deficiencies in area 2. Taking land situated in area 1 and 3 into cultivation will require the application of phosphatic fertilizers. Experience with local soils indicates that an application of 500kg super phosphate (10,5% P) per hectare is usually sufficient to raise the P status to more acceptable levels, where only maintenance of the P-status is required.

2.4 SUITABILITY OF THE LAND FOR RAINFED AND IRRIGATED CROPPING

2.4.1 Introduction

The assessment of the land for rainfed and irrigated cropping is based mainly on results obtained by the Ecotope Project (Van Averbeke & Marais, 1991). This project investigated the cropping potential of Ciskeian ecotopes for rainfed cropping and evaluated the suitability of a number of management practices aimed at optimizing crop production on these ecotopes. Field experiments on more than 20 ecotopes were conducted over a ten year period. Knowledge of the behaviour and problems of local soils were extrapolated to predict the suitability of the Scenery Park soils for irrigated crop production.

This assessment of the suitability of the land for crop production is based mainly on soil characteristics. Slope of the land, which is an important factor determining the suitability of land for crop production, especially under irrigation, could not be assessed adequately, because of the poor resolution of the base map. Where possible, reference will be made to problems related to the slope of particular areas. These references are based on field observations and they are qualitative only.

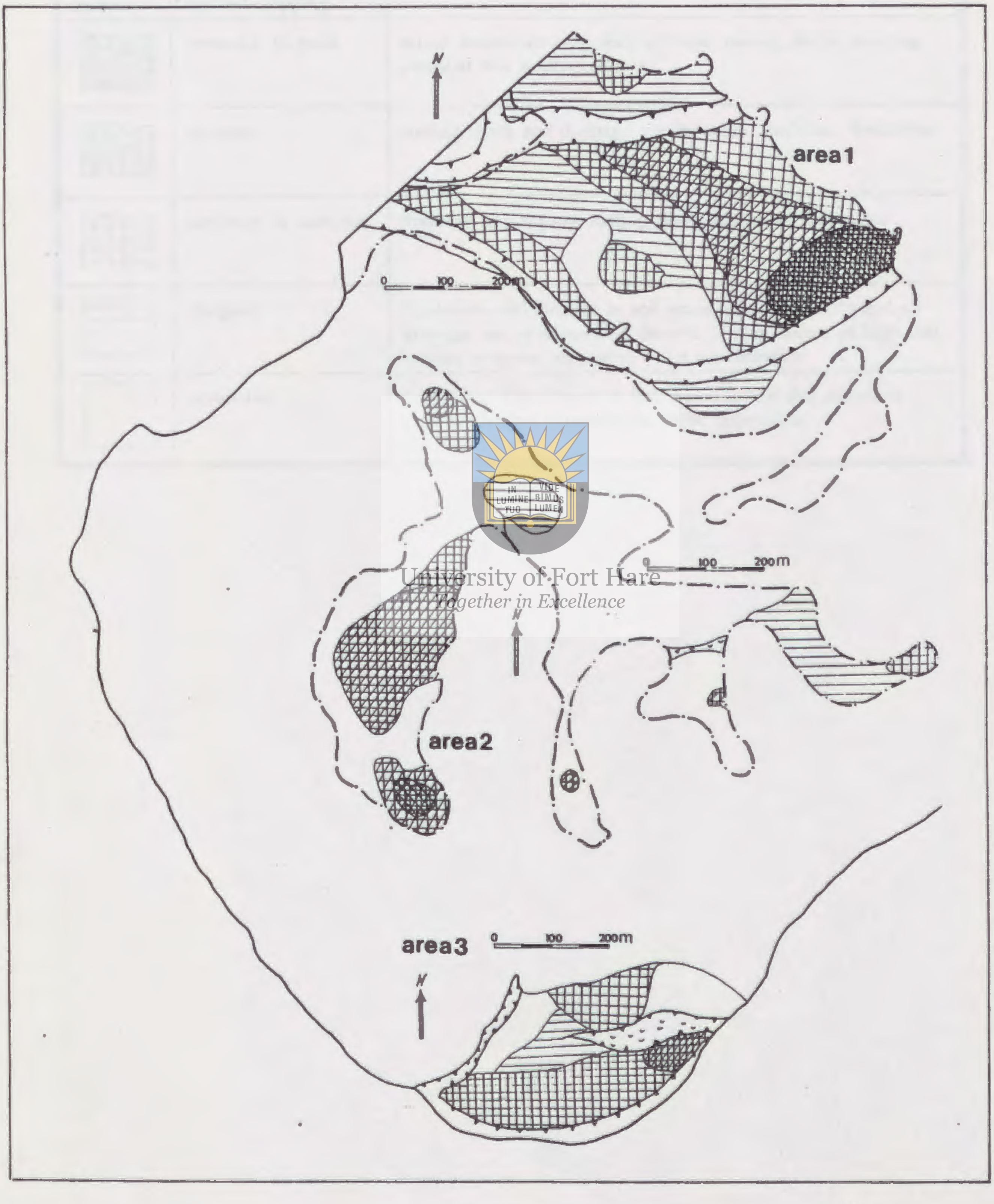
2.4.2 Suitability of the land for rainfed cropping

The land was subdivided into five suitability classes. The main factors that were considered when classifying the suitability of the land for rainfed cropping were:
1) the capacity of a soil to supply the crop with water,
and
2) the ease by which excess water is removed (drained) from the rooting zone.

In rainfed cropping, the first factor is the most important one, because it determines the period of time a crop can rely on the stored soil water reserves. Crops grown on soils with inadequate storage capacity will easily be subjected to water stress, which, in turn, will reduce yields and increase the risk of total crop failure. Where the risk of crop failure is thought to be unacceptably high, the land or soil concerned is assessed as being unsuitable for crop production. The best land at Scenery Park is thought to be of moderate to good suitability. Such land is thought to be able to produce an economically profitable crop in at least 3 out of 4 seasons. The probability to produce such a crop will be reduced to 2 out of 3 seasons for moderately suitable land, 1 out of 2 seasons for land that has a suitability rating of moderate to marginal and 1 out of 3 seasons for marginal land.

The results of the assessment are presented in Table 2.2 and Figures 2.5, 2.6, 2.7 and 2.8.

Figure 2.5. Suitability of the land in Scenery Park for rainfed cropping.



LEGEND

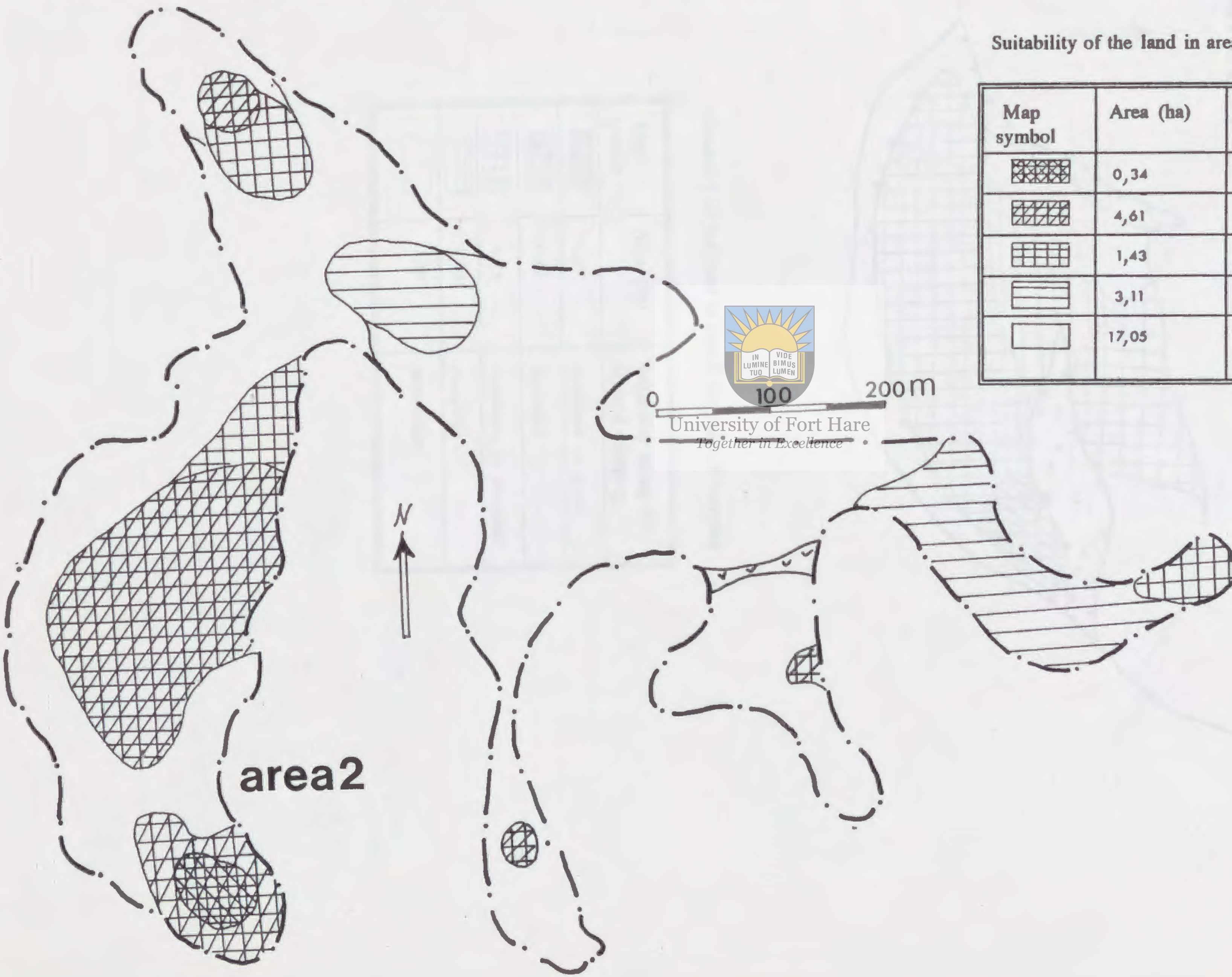
Map symbol	Suitability rating for dryland cropping	Limitations
	moderate to good	minor limitations only, such as slope, rooting depth, crusting potential and infiltration rate
	moderate	rooting depth and drainage are the main, moderate limitations
	moderate to marginal	drainage and shallow rooting depth are major limitations
	marginal	limitations with respect to soil water storage capacity and or drainage are so severe and the risk of crop failure so high that rainfed cropping may prove to be uneconomical
	unsuitable	limitations with respect to soil are so severe that sustained crop production is considered to be impossible

Figure 2.6. Suitability of the land in area 1 for rainfed cropping.

Suitability of the land in area 1 for rainfed cropping

Map symbol	Area (ha)	Suitability rating for dryland cropping
	2,34	moderate to good
	4,53	moderate
	7,77	moderate to marginal
	7,29	marginal
	14,68	unsuitable

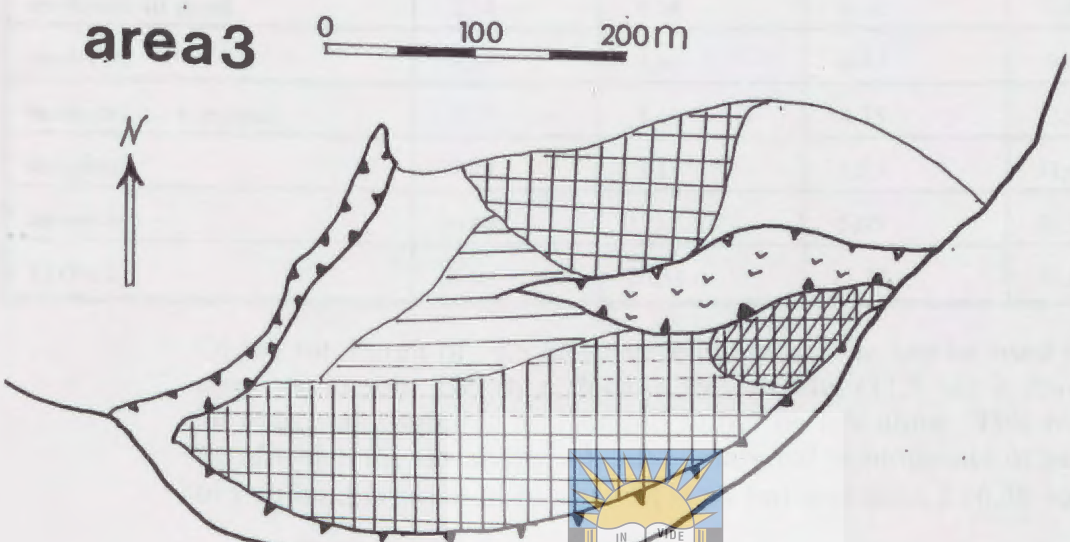
Figure 2.7. Suitability of the land in area 2 for rainfed cropping.



Suitability of the land in area 2 for rainfed cropping

Map symbol	Area (ha)	Suitability rating for dryland cropping
	0,34	moderate to good
	4,61	moderate
	1,43	moderate to marginal
	3,11	marginal
	17,05	unsuitable

Figure 2.8. Suitability of the land in area 3 for rainfed cropping.



Suitability of the land in area 3 for rainfed cropping

Map symbol	Area (ha)	Suitability rating for dryland cropping
	0,00	moderate to good
	0,47	moderate
	4,75	moderate to marginal
	1,05	marginal
	5,05	unsuitable

Table 2.2. Suitability of Scenery Park for rainfed crop production

Rating	Area 1 (ha)	Area 2 (ha)	Area 3 (ha)	Total (ha)
moderate to good	2,34	0,34	0,00	2,68
moderate	4,53	4,61	0,47	9,61
moderate to marginal	7,77	1,43	4,75	13,95
marginal	7,29	3,11	1,05	11,45
unsuitable	14,68	17,05	5,05	36,78
TOTAL	36,61	26,54	11,32	74,47

Of the total area of 74,5 ha surveyed only 36,8 ha can be used for rainfed crop production. Nearly a third of this 36,8 ha (11,5 ha) is considered to be marginally suitable and should rather be left alone. This leaves 26,24 ha of which the suitability was rated marginal to moderate or better. Most of this land is situated in area 1 (14,64 ha) and area 2 (6,38 ha).

It needs mentioning that steep slopes occur in parts of the land forming the northern boundary of area 1 and parts of the land adjacent to the water way which forms the southern boundary of area 1. The need for conservation measures on these lands may put into question their suitability for crop production.

2.4.3 Suitability of the land for irrigated cropping

The land was subdivided into six suitability classes. Here also, the main factors that were considered when classifying the suitability of the land for irrigated cropping were:
1) the capacity of a soil to supply the crop with water,
and
2) the ease by which excess water is removed (drained) from the rooting zone.

However, when assessing the suitability of land for irrigated cropping the second factor, namely the internal drainage of a soil, is of utmost importance. Scenery park does not have much well drained land and the general suitability for irrigated cropping is not so good.

Land rated moderate to good is thought to be virtually free of problems. Reasonable water storage capacity of the soil makes it possible to use reasonably long irrigation cycles and excess water is expected to drain more or less freely to below the rooting zone. Lands considered moderately suitable for irrigated cropping are expected to give drainage problems in wet seasons or their storage capacity is limited, requiring shorter irrigation cycles and more careful management. These two limitations get more severe in lands rated moderate to marginal and marginal. Lands rated very marginal will require major land improvements and very high management in order to sustain production. Where the required land improvements are thought to be uneconomical, the land is rated unsuitable.

The results of the assessment is presented in Table 2.3 and Figures 2.9, 2.10, 2.11 and 2.12. The distribution of the land suitable for irrigation is similar as that for rainfed cropping.

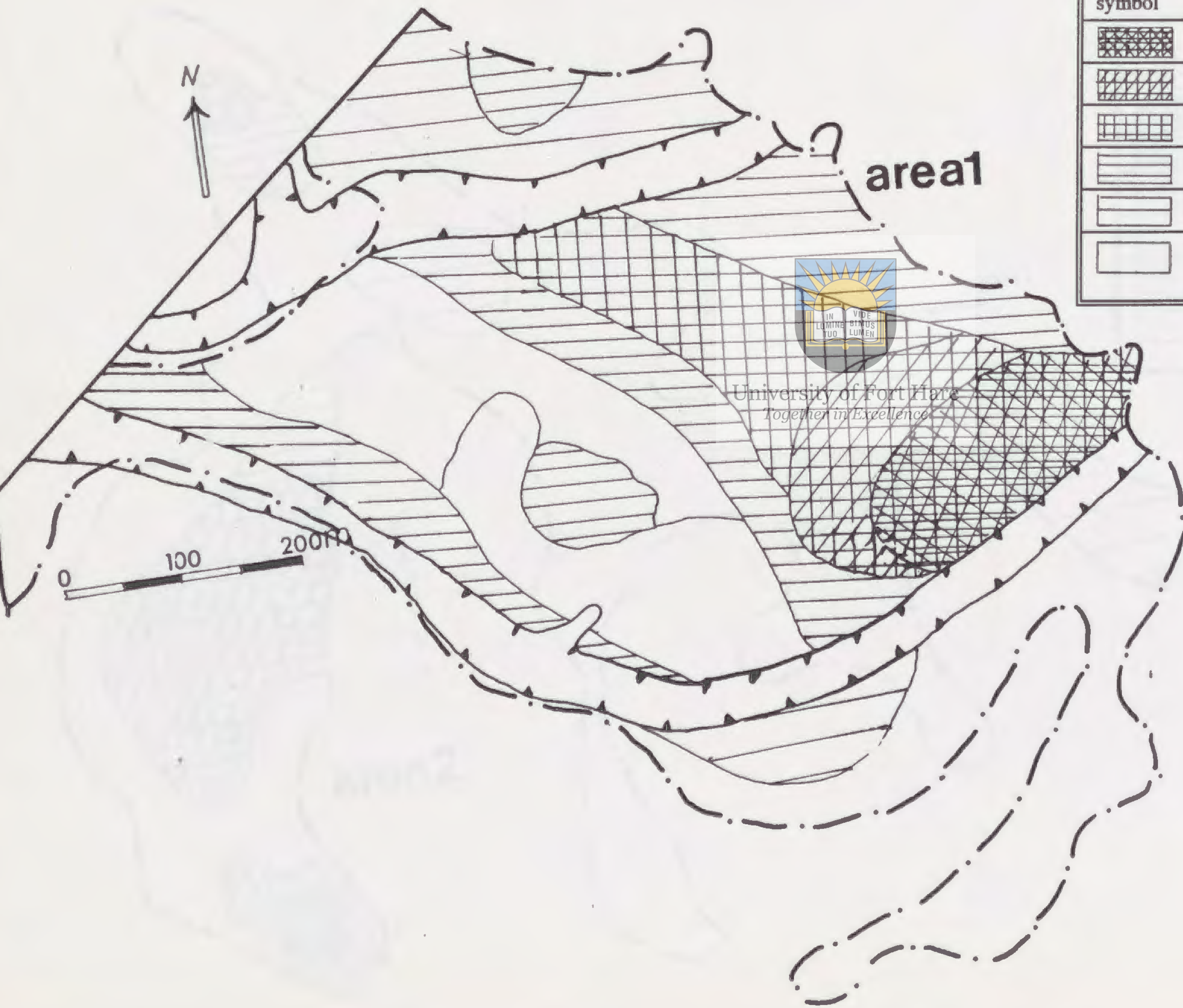
Table 2.3. Suitability of Scenery Park for irrigated crop production

Rating	Area 1 (ha)	Area 2 (ha)	Area 3 (ha)	Total (ha)
moderate to good	2,34	0,34	0,00	2,68
moderate	1,67	2,18	0,47	4,32
moderate to marginal	2,86	2,43	0,00	5,29
marginal	7,77	1,43	4,75	13,95
very marginal	7,29	3,11	1,05	11,45
unsuitable	14,68	17,05	5,05	36,78
TOTAL	30,61	26,54	11,32	74,47

LEGEND

Map symbol	Suitability rating for irrigated cropping	Limitations
	moderate to good	minor limitations only, such as slope, rooting depth, crusting potential and infiltration rate
	moderate	rooting depth and drainage are the main, moderate limitations
	moderate to marginal	drainage and shallow rooting depth are major limitations
	marginal	drainage problems or shallow rooting depth preclude the land from being used in its natural state, i.e.land improvements are necessary
	very marginal	limitations with respect to soil are so severe that sustained crop production is possible only after major land improvements and even then the management requirements will remain very high
	unsuitable	generally the limitations prohibit the economic use of the land for irrigated cropping

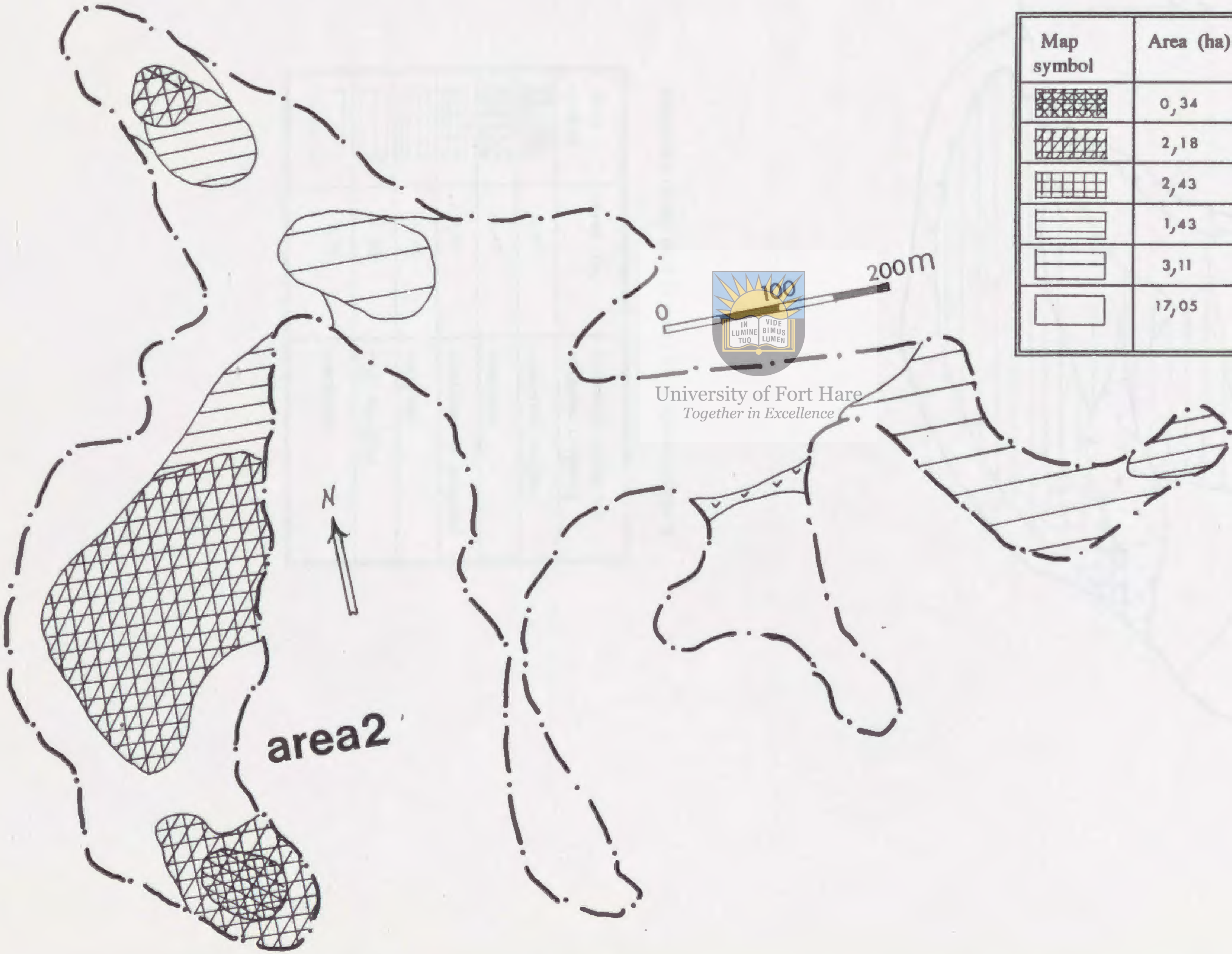
Figure 2.10. Suitability of the land in area 1 for irrigated cropping.



Suitability of the land in area1 for irrigated cropping

Map symbol	Area (ha)	Suitability rating for irrigated cropping
[cross-hatched, dense]	2,34	moderate to good
[diagonal hatched]	1,67	moderate
[grid]	2,86	moderate to marginal
[close horizontal lines]	7,77	marginal
[wide horizontal lines]	7,29	very marginal
[blank]	14,68	unsuitable

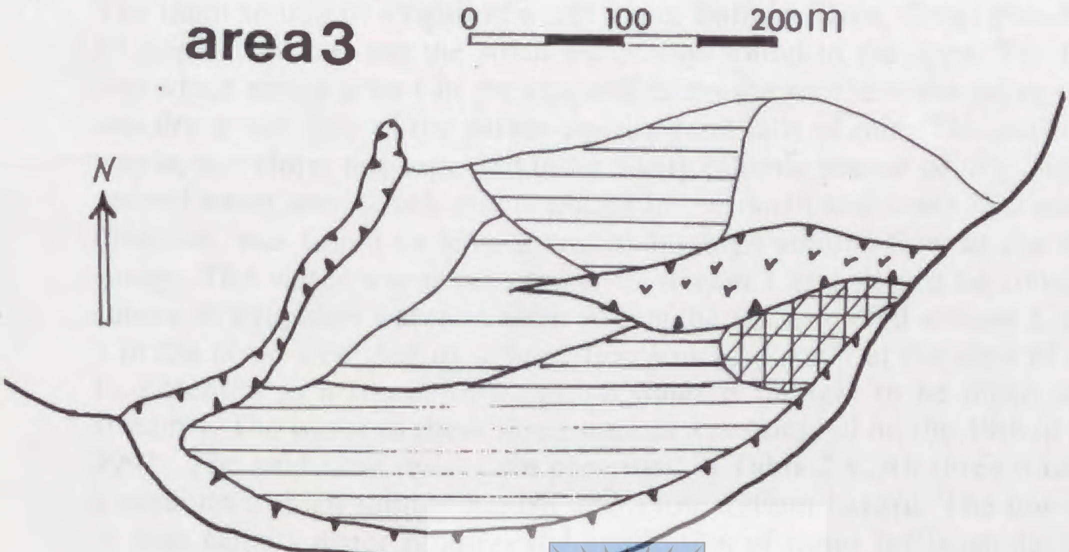
Figure 2.11. Suitability of the land in area 2 for irrigated cropping.



Suitability of the land in area2 for irrigated cropping

Map symbol	Area (ha)	Suitability rating for irrigated cropping
	0,34	moderate to good
	2,18	moderate
	2,43	moderate to marginal
	1,43	marginal
	3,11	very marginal
	17,05	unsuitable

Figure 2.12. Suitability of the land in area 3 for irrigated cropping.



Suitability of the land in area3 for irrigated cropping

Map symbol	Area (ha)	Suitability rating for irrigated cropping
	0,00	moderate to good
	0,47	moderate
	0,00	moderate to marginal
	4,75	marginal
	1,05	very marginal
	5,05	unsuitable

2.5 WATER RESOURCES AND QUALITY

The main source of irrigation water is the **Buffalo River**. Other possible sources of irrigation water are the small water ways found in the area. The main water way which enters area 1 in the east and forms the southern boundary of that area was dry at the time of the survey despite good falls of rain. This particular water way is, therefore, not expected to be a very reliable source of irrigation water. A second water way, which enters area 1 in the north and flows in a southwestern direction, was found to have a reasonably high volume-flow at the time of the survey. This water way is referred to as **stream 1** and should be considered as a source of irrigation water. A third stream, hereafter called **stream 2**, enters area 1 in the north west, but its volume-flow was very small at the time of the survey. Its potential as a source of irrigation water is thought to be much less than of stream 1. The water of these three sources was sampled on the 19th of November 1993 . The analytical results are presented in Table 2.4. All three waters present a medium to high salinity hazard and a low sodium hazard. The use of medium to high salinity water requires the application of water for leaching, in order to avoid a build-up of salts in the soil. Fortunately the rainfall in Scenery Park is relatively high and the action of salt-free rain water percolating through the soil profile from time to time should reduce the need for leaching considerably.

Table 2.4. Quality of three possible sources of irrigation water.

Source	Sodium adsorbtion ratio	Electrical conductivity ($mS\ m^{-1}$)	Salinity hazard	Sodium hazard
Buffalo river	2,66	88	medium to high	low
Stream1	2,31	94	medium to high	low
Stream 2	2,24	71	medium to high	low

ANALYTICAL DATA FOR PROFILE 1

Lab. No.	100/93	101/93
Horizon	Ap	B21
Particle size distribution (%)		
co Sa	1,2	2,4
me Sa	1,4	1,0
fi Sa	6,1	5,8
vf Sa	20,2	16,6
Total Sand	**28,6**	**25,8**
co Si	22,9	23,0
fi Si	30,1	30,1
Total Silt	**53,0**	**53,1**
Clay	18,2	21,2
Exchangeable cations (me/100 g soil)		
Ca	8,765	7,535
Mg	3.975	4,308
K	0,343	0,169
Na	0,274	0,852
S - value (me/100 g soil)	13,357	12,864
Exchangeable acidity (me/100 g soil)	0,04	0,05
Cation exchange capacity (me/100 g soil)	13,397	12,914
Organic Carbon (%)	0,68	
pH water 1:2,5	6,9	7,3
pH KCl	6,0	6,0
EC 25^0C mS/m		

ANALYTICAL DATA FOR PROFILE 2

Lab. No.	102/93
Horizon	A1
Particle size distribution (%)	
co Sa	1.6
me Sa	1.6
fi Sa	7.2
vf Sa	13.4
Total Sand	**23.8**
co Si	23.9
fi Si	32.8
Total Silt	**56.7**
Clay	19.5
Exchangeable cations (me/100 g soil)	
Ca	8,885
Mg	5,517
K	0,355
Na	0,404
S - value (me/100 g soil)	15,161
Exchangeable acidity (me/100 g soil)	0,07
Cation exchange capacity (me/100 g soil)	15,231
Organic Carbon (%)	0,74
pH water 1:2,5	6,9
KCl 1:2,5	5,6
EC $25^{0}C$ mS/m	

ANALYTICAL DATA FOR PROFILE 3

Lab. No.	103/93	104/93
Horizon	Ap	B21
Particle size distribution (%)		
co Sa	0,2	0,7
me Sa	1,2	1,1
fi Sa	11,4	8,8
vf Sa	21,2	13,8
Total Sand	**34,0**	**24,4**
co Si	25,2	22,5
fi Si	26,3	28,5
Total Silt	**51,5**	**51,0**
Clay	14,5	24,5
Exchangeable cations (me/100 g soil)		
Ca	5,595	8,210
Mg	3,550	6,375
K	0,312	0,174
Na	0,287	0,722
S - value (me/100 g soil)	9,744	15,481
Exchangeable acidity (me/100 g soil)	0,06	0,06
Cation exchange capacity (me/100 g soil)	9,804	15,541
Organic Carbon (%)	0,35	
pH water 1:2,5	7,1	7,6
pH KCl 1:2,5	5,6	5,7
EC 25^0C mS/m		

ANALYTICAL DATA FOR PROFILE 4

Lab. No.	106/93	107/93
Horizon	A1	B21
Particle size distribution (%)		
co Sa	0,5	0,8
me Sa	3,8	3,7
fi Sa	32,5	32,0
vf Sa	19,2	17,5
Total Sand	**56,0**	**50,4**
co Si	15,7	13,6
fi Si	18,8	17,3
Total Silt	**34,5**	**30,9**
Clay	9,5	15,1
Exchangeable cations (me/100 g soil)		
Ca	2,785	3,695
Mg	1,525	1,750
K	0,169	0,077
Na	0,135	0,291
S - value (me/100 g soil)	4,614	5,813
Exchangeable acidity (me/100 g soil)	0,06	0,06
Cation exchange capacity (me/100 g soil)	4,674	5,873
Organic Carbon (%)	0,20	
pH water 1:2,5	6,8	6,9
KCl 1:2,5	5,2	5,2
EC 25^{0}C mS/m		

ANALYTICAL DATA FOR PROFILE 5

Lab. No.	108/93	109/93	110/93
Horizon	A1	B21	B22
Particle size distribution (%)			
co Sa	0,8	0,9	0,7
me Sa	0,8	0,8	1,3
fi Sa	5,4	4,8	4,7
vf Sa	17,6	15,0	9,8
Total Sand	**24,6**	**21,5**	**16,5**
co Si	26,8	23,3	21,0
fi Si	33,2	31,0	32,2
Total Silt	**60,0**	**54,3**	**53,2**
Clay	15,4	24,2	30,4
Exchangeable cations (me/100 g soil)			
Ca	8,860	8,760	10,300
Mg	2,100	3,683	5,250
K	0,409	0,292	0,110
Na	0,209	0,452	0,748
S - value (me/100 g soil)	11,578	13,187	16,408
Exchangeable acidity (me/100 g soil)	0,07	0,07	0,05
Cation exchange capacity (me/100 g soil)	11,648	13,257	16,458
Organic Carbon (%)	0,90		
pH water 1:2,5	7,0	7,6	7,9
pH KCl 1:2,5	5,7	5,7	5,8
EC 25^{0}C mS/m			

ANALYTICAL DATA FOR PROFILE 6

Lab. No.	111/93	112/93	113/93
Horizon	A1	B21	B22
Particle size distribution (%)			
co Sa	4,0	1,7	4,0
me Sa	2,2	2,4	3,0
fi Sa	18,6	19,5	20,5
vf Sa	18,2	18,1	12,9
Total Sand	**43,0**	**41,7**	**40,4**
co Si	20,4	18,3	19,9
fi Si	22,8	21,9	17,7
Total Silt	**43,2**	**40,2**	**37,6**
Clay	13,7	18,2	22,0
Exchangeable cations (me/100g soil)			
Ca	4,935	8,700	9,225
Mg	1,792	3,100	3,217
K	0,110	0,064	0,059
Na	0,183	0,317	0,361
S - value (me/100g soil)	7,020	12,181	12,862
Exchangeable acidity (me/100g soil)	0,08	0,10	0,02
Cation exchange capacity (me/100g soil)	7,090	12,281	12,882
Organic Carbon (%)	0,86		
pH water 1:2,5	6,5	6,8	7,2
pH KCl 1:2,5	4,9	5,3	5,6
Ec 25^{0}C mS/m			

SECTION 3

CLIMATE AND ASSESSMENT OF HORTICULTURAL POTENTIAL

3.1 CLIMATE OF EAST LONDON, AND SCENERY PARK IN PARTICULAR

3.1.1 INTRODUCTION

Tancred (1972) classified the climate of the Eastern Cape on the basis of Köppen and Thornthwaite classifications. The climate of Ciskei, including areas in close proximity to East London, was described by Marais (1975) and by Austin (1989a).

No climatic data is available specifically for Scenery Park. The nearest weather stations are at the Agricultural Research Station and nearby at Ben Schoeman Airport. The climatic data of these two stations are presented in Tables 3.1 to 3.3. There is not much difference between them. Records have been kept for more years at Ben Schoeman airport.

Marais (1975) stated that broad geographic classifications of macroclimatic zones are too general and non-specific to provide a basis for agricultural planning and therefore more detailed description and demarcation are required by the agriculturalist. In Table 3.4 we have described the climate of East London according to four authorities, namely Köppen and Thornthwaite (according to Tancred, 1972), Ehlers (1974) and Wolstenholme (1977).

Hensley and Laker (1975) described the various land types of Ciskei. It would appear that the Chalumna and Bekruipkop land types approximate the land types of interest to us in East London. It must be pointed out that the developed part of Scenery Park differs somewhat from the lower-lying valley areas of the farm which form the subject of this investigation. The latter is also lower lying than the areas represented by the Agricultural Research Station and Ben Schoeman Airport. The valley is presumably more sheltered and perhaps slightly warmer in summer and slightly colder in winter.

Land and sea breezes are a common feature of the coastal belt during all seasons but strong and persistent westerly and easterly winds may be experienced and may reach gale force.

Rainfall is more or less evenly distributed during spring, summer and autumn.

Table 3.1 Mean air temperatures (°C) recorded at two weather stations in close proximity to Scenery Park, East London (data from: Climate of South Africa, WB40, Weather Bureau, Dept. of Environment Affairs, Government Printer, Pretoria 1986)

Month	Means of					
	Daily Max		Daily Min		Max + Min / 2	
	*BS	**AGR	BS	AGR	BS	AGR
January	25,4	25,4	18,1	17,8	21,7	21,7
February	25,6	25,5	18,4	18,0	22,0	21,8
March	24,9	24,8	17,5	17,0	21,2	20,9
April	23,6	23,7	15,0	14,9	19,3	19,3
May	22,4	22,4	12,7	12,6	17,5	17,5
June	21,1	21,0	10,7	10,7	15,9	15,8
July	20,9	20,8	10,3	10,4	15,6	15,5
August	21,0	20,4	10,9	10,4	15,9	15,4
September	20,9	20,6	12,3	11,9	16,6	16,3
October	21,4	21,4	13,9	13,2	17,7	17,3
November	22,8	22,6	15,4	14,7	19,1	18,6
December	24,3	24,3	19,9	16,3	20,5	20,3
	22,9	22,7	14,4	14,0	18,7	18,4

*BS = Ben Schoeman Airport (data 1939-1984)
33°02'S 27°50'E Alt. 125 m

**AGR = Agricultural Research station (data 1967-1984)
33°01'S 27°48'E Alt. [illegible] m

Table 3.2 Absolute air temperatures (°C) recorded at two weather stations in close proximity to Scenery Park, East London. (data from: Climate of South Africa, WB40, Weather Bureau, Dept. of Environment Affairs, Government Printer, Pretoria 1986)

Month	Absolute Max		Absolute Min	
	*BS	**AGR	BS	AGR
January	35,8	38,9	9,0	12,2
February	42,6	36,9	11,0	12,2
March	38,6	38,4	10,3	9,3
April	35,9	35,8	7,2	8,6
May	37,0	36,3	4,4	5,2
June	32,8	31,4	2,6	2,5
July	34,1	32,6	1,8	2,9
August	37,5	35,2	3,1	-1,0
September	41,7	40,9	5,0	4,5
October	40,9	38,8	5,9	5,1
November	40,3	34,3	8,5	9,3
December	28,2	36,5	8,4	9,5

BS = Ben Schoeman Airport (1939-1984)
AGR = Agricultural Research Station (1967-1984)

Table 3.3 Mean monthly precipitation for East London (data from: Climate of South Africa, WB40, Weather Bureau, Dept. of Environment Affairs, Government Printer, Pretoria 1986)

Month	Mean precipitation (mm)	
	*AGR	*BS
January	65	74
February	102	95
March	77	106
April	66	80
May	44	55
June	40	40
July	53	51
August	76	51
September	74	93
October	90	95
November	88	90
December	74	74
	849	904

*AGR = Agricultural Research Station (1967 to 1984)
* BS = Ben Schoeman Airport (1951 to 1984)

3.1.2 MAJOR TEMPERATURE AND RAINFALL FEATURES AS THEY RELATE TO AGRICULTURAL POTENTIAL

Mean maximum, minimum and daily temperature data are presented in Table 1. The proximity of the Indian ocean and the warm Mozambique Current help to create a pleasant climate without the greater extremes in temperature that are experienced further inland. The mean annual temperature for East London is 18,7°C at Ben Schoeman airport and a fraction lower at the Research Station just across the Buffalo River from Scenery Park. The mean daily temperature range is a mere 8,5°C. The mean annual maximum at Ben Schoeman is 22,9°C and a fraction lower at the Research Station. Temperatures in the Buffalo River valley at Scenery Park may be somewhat higher in summer. The mean daily minimum temperature at Ben Schoeman Airport is 14,4°C and 14,0°C at the Research Station. According to Wolstenholme (1977) the lower boundary for a sub-tropical climate in South Africa is taken to be approximately 13°C (mean for July) and the higher boundary approximately 18°C.

Absolute maximum and minimum temperatures are presented in Table 3.2. Higher temperatures have been recorded at Ben Schoeman Airport than at the Research Station (absolute maximum temperatures of 42,6°C and 40,9°C, respectively). Surprisingly, very high temperatures can be experienced in September. High temperatures of a short duration are usually relatively harmless to crops but if they persist for two or three days they can result in sunburn (for example with mature pineapple fruits along the coast and with mature prickly pear fruits inland e.g. at Alice).

Of particular interest in determining cropping potential are absolute minimum temperatures, particularly when dealing with perennial crops.

One would expect the East London area to be free of frost. However, it may be seen from Table 3.2 that the absolute minimum for the Research Station is -1°C (for August). Frost has never been recorded at Ben Schoeman Airport. One would not expect frost to occur at Scenery Park, but being in a River Valley it cannot be ruled out altogether if it has been recorded on the higher-lying ground of the Research Station. In this regard the experience of long-established residents of Scenery Park and neighbouring areas may be useful.

High spring and summer temperatures, particularly if experienced over a relatively extended period and during periods of drought, could result in important stress to crops grown under dryland conditions.

Apart from temperature, rainfall (amount and distribution) is a major climatic factor determining agricultural potential and production practices. Austin (1989a,b) completed an analysis of the variability and spatial distribution of monthly rainfall for Ciskei but some of the data also relates to the East Londnon area. According to him, in drier areas (as occur in the Eastern Cape and Ciskei) "mean annual rainfall can often be misleading because the mean does not occur with sufficient frequency to be used as a statistic for planning purposes. As a result, estimates of expected growing season rainfall at various probabilities are required".

Austin (1989a,b) calculated and plotted on maps the minimum expected rainfall for 10 possible growing seasons for the 75% and 50% levels of probability. Agricultural production planners generally plan on the basis of predictions which are realised in three out of four years. "The rainfall received is the most important factor determining yield. For planning purposes, the expected rainfall is the most important factor determining levels of inputs such as fertilizer and plant population (for dryland cropping). Expected rainfall thus determines to a great extent the target yield (ie. that yield the farmer should attempt to achieve)".

Data that can be accessed on a mainframe computer relate to the area that lies between 31°45'23" and 33°45'22"S latitude between 26°15'23" and 28°00'22" E longitude and bounded by the Indian Ocean in the south-east.

Mean evaporation from a Class A Pan amounts to 1 715 mm per annum, with a high of 198 mm in January and a low of 86 mm in May. On average 34% of evaporation occurs in summer, 20% in autumn, 18% in winter and 28% in spring. Mean figures for some other areas are as follows:

Port Elizabeth	1 948 mm per annum
Cape Town	2 141 mm per annum
Durban	1 755 mm per annum
Upington	3 805 mm per annum

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Cape Town	2 141 mm per annum
Durban	1 755 mm per annum
Upington	3 805 mm per annum

Wind roses for East London and other centres in South Africa, for comparative purposes, are shown in Figures 3.1 and 3.2 (for January and July, respectively). Easterly and westerly winds are dominant, although northerly winds may also prevail at certain times of the year (Figure 3.2).

Windbreaks, whether in the form of trees (eg. *Casuarina cunninghamiana* or Beefwood) or herbaceous protection (eg. Napier Fodder, as is frequently used in the East London area for protecting vegetables) would undoubtedly be beneficial with any form of cultivation.

Hail is rare in East London and cannot be considered to be a limiting factor for crop production. Hail frequency is lower than in most parts of the country.

3.1.3 THE KöPPEN AND THORNTHWAITE CLASSIFICATIONS OF MACROCLIMATIC ZONES

In determining crop potential, particularly for dryland or rainfed cropping, it is important to be able to estimate water requirements using temperature, rainfall and related data.

Tancred (1972) analysed the climate of the Eastern Cape according to the systems developed by Köppen and Thornthwaite. Their relative merits are discussed by Marais (1977). Some features are presented in Table 3.4 for East London.

Köppen's classification is based on temperature, precipitation and natural vegetation. The classification of C fw' bl for East London designates a continually moist climate (f), a droughty winter (w') and a hot summer (b), although generally with moderate means (l).

According to Marais (1975) Thornthwaites classification of climate places the major emphasis on the water factor in that the water income is assessed in relation to water requirements by means of a moisture index. In addition, the seasonal variation of humidity is more fully described than in the case of Köppen's classification. Furthermore, the temperature regime, which is described by his thermal efficiency index, is assessed on the basis of annual potential evapotranspiration. There is also an indication of the proportion of heat accumulated in the three summer months - the so-called summer concentration of thermal energy.

Notable features of the climate of East London, according to Tancred's application of the Thornthwaite classification, is the relatively gradual thermal summation throughout the year, as denoted by a'. Furthermore, the area is denoted as "dry-subhumid" compared to Köppen's "continually moist".

PIETERSBURG
PRETORIA
KEETMANSHOOP
POTCHEFSTROOM
JAN SMUTS
PIET RETIEF
UPINGTON
ALEXANDER BAY
KIMBERLEY
LADYSMITH
BLOEMFONTEIN
DURBAN
GROOTFONTEIN
VICTORIA WEST
BEAUFORT WEST
MATROOSBERG
EAST LONDON
BIEN DONNE
PORT ELIZABETH
GEORGE
CAPE TOWN
25°
30°
WIND ROSES — JANU
WINDROSE — JANU
SLEUTEL - KEY
3-8
9-15
16-25
26-38
>38

Figure 3.1

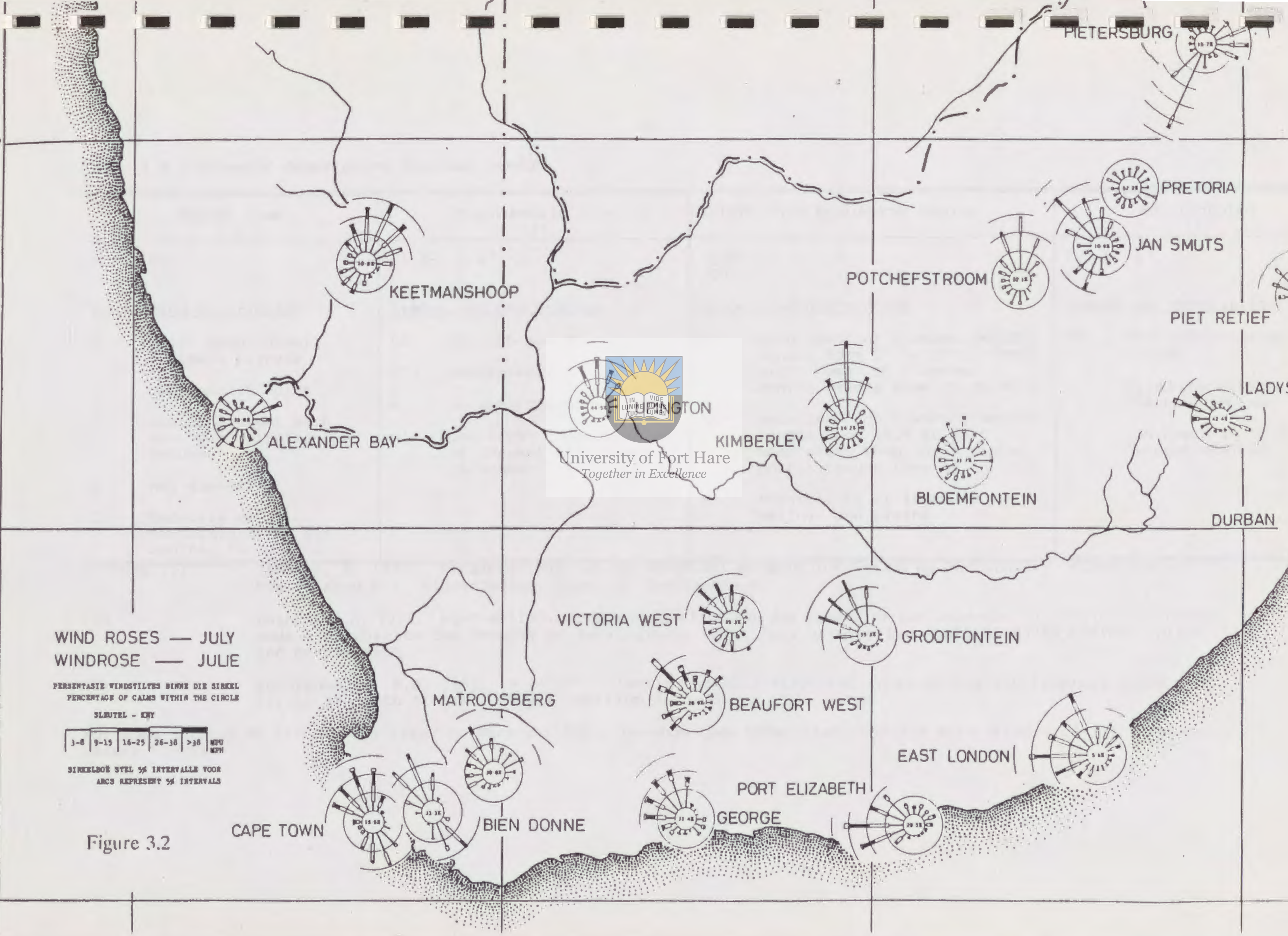
PIETERSBURG
PRETORIA
JAN SMUTS
POTCHEFSTROOM
PIET RETIEF
KEETMANSHOOP
ALEXANDER BAY
KIMBERLEY
BLOEMFONTEIN
DURBAN
VICTORIA WEST
GROOTFONTEIN
BEAUFORT WEST
MATROOSBERG
EAST LONDON
PORT ELIZABETH
GEORGE
BIEN DONNE
CAPE TOWN
WIND ROSES — JULY
WINDROSE — JULIE
PERSENTASIE WINDSTILTES BINNE DIE SIRKEL
PERCENTAGE OF CALMS WITHIN THE CIRCLE
SLEUTEL - KEY
3-8 9-15 16-25 26-38 >38 MPU MPH
SIRKELBOË STEL 5% INTERVALLE VOOR
ARCS REPRESENT 5% INTERVALS

Figure 3.2

Table 3.4 Climatic description for East London

Köppen Zone (1)		Thornthwaite Zone (2)		Ehlers Agro-Ecological Region (3)		Wolstenholme (4)	
C fw' bl		C1 B'3 d a'		67B / 46		IV, C, 3	
Symbol and description		Symbol and description		Symbol and description		Symbol and description	
C	Moist mesothermal ("tree") climate	C1	Dry sub-humid	67	Mean temp. of 3 summer months ranges form 21 to 22°C. Mean night temp. of 3 summer months ranges from 15 to 20°C	IV	Cool sub-tropical region
f	continually moist	B'3	Mesothermal	46	Mean temp. of 3 winter months ranges from 15,5 to 19°C. Mean night temp. of 3 winter months ranges from 10 to 15°C	C	Annual precipitatio 800 to 1 000 mm
w'	winter drought with max. precipitation in autumn	d	no water surplus	B	Possibility of frost in valleys and plains	3	Sub-humid (4 to 5 drought months)
b	Hot summer	a'	low (48%) concentration of thermal efficiency in summer				
l	Moderate mean temperature for all months, 10 to 22°C						

(1) and (2) Tancred, P. 1972. Klimaatstipes van Oos-Kaapland volgens die Köppen en Thornthwaite Klassifikasie. Unpublished M.A. dissertation, Univ. of Stellenbosch,

(3) Ehlers, J.H. 1974. Agro-ekologiese streekindeling van die Republiek van Suid-Afrika. Report and maps made available to the Faculty of Agriculture, Univ. Fort Hare by the Dept. of Bantu Administration and Development.

(4) Wolstenholme, B.N. 1977. A simple climatic classification for tropical and sub-tropical areas and fruits in South Africa. Crop Production 6,35-39.

For more details of (1) and (2) refer to Marais (1975), by whom they were cited, and for more details of (3) refer to Marais (1990).

According to Marais (1975) "the greatest value of the Köppen and Thornthwaite systems, with regard to agricultural planning, lies in the characterisation of the moisture factor" He regards Thornthwaite as being more meaningful in that his system of water budgeting enables an assessment of the "annual march of potential evapotranspiration" and identification of the following periods:

(i) Periods of water surplus
(ii) Periods of water deficit
(iii) Periods of soil moisture utilization
(iv) Periods of soil moisture recharge

Elsewhere we calculate the water requirements for maize under dryland conditions at Scenery Park. Fair to good yields of maize are to be expected on suitable soil owing to deferred utilization by a summer crop of stored moisture accumulated in spring. However, a severe limitation is the mid-summer deficits. This period could be avoided by planting earlier maize crops.

3.1.4 AGRO-ECOLOGICAL CLASSIFICATION OF REGIONS ACCORDING TO EHLERS

Ehlers (1974) divided South Africa into different so-called "agro-ecological regions" based upon the temperature requirements of crops. For East London the Ehlers code would be $\frac{67A}{46}$ or $\frac{67B}{46}$ depending on the total absence of frost (A) or the possibility of light frost in the plains or valleys (B). Details of this system are provided by Marais (1990), including a listing of crops and their adaptability to the various agro-ecological zones. See Appendix 1.

3.1.5 A SIMPLE CLIMATIC CLASSIFICATION FOR TROPICAL AND SUB-TROPICAL AREAS AND FRUITS IN SOUTH AFRICA

According to Wolstenholme (1977), East London is classified as having a cool sub-tropical coastal climate. He lists fruit crops suited to such a climate. Especially on a home or subsistence scale of production it is possible to grow a wider range of crops and cultivars than would be considered for extensive commercial cropping. See Appendix 2.

3.1.6 GENERAL REMARKS WITH REGARD TO CLIMATE AND CROPPING POTENTIAL

Most vegetables can be grown with success at some time or other during the year in East London, particularly as frost is not a limiting factor. Maize and potatoes, as well as other field crops, will do well under dryland or with supplementary irrigation. Winter cereals would not be recommended. Pasture grasses could be established with success.

The proximity of the Agricultural Research Station to Scenery Park is a great advantage in assessing what can be grown here. Although the research station has concentrated on pineapples, they have in the past established trial plantings of other horticultural crops.

It must be remembered that temperature and rainfall/ irrigation are but two of the many factors determining agricultural potential. Soils and topography can be severe limiting factors. The less favourable the conditions the more risky the enterprise and the higher the level of management required. In addition there are socio-economic and marketing considerations.

3.2 POTENTIAL CROPS FOR SCENERY PARK

The potential for cropping on an extensive scale at Scenery Park would appear to be rather limited because of the poor availability of soils with a good or high potential. There are other limitations in terms of the topography, which in turn influence pumping and irrigation costs. The area may be better suited to livestock enterprises or spared as a nature reserve. The evaluation that follows is made purely on the basis of climate, soil and some socio-economic considerations.

3.2.1 VEGETABLES

The commercial growing of vegetables is an important activity on the outskirts of East London particularly to the north-east but also close to Scenery Park. The growing of vegetables and maize on vacant land in Mdantsane is surprising (being an urban area) yet most encouraging.

Commercial production of vegetables requires optimum or near-optimum growing conditions and a relatively high level of management. On the other hand small-scale vegetable production for home gardens/subsistence can also be performed under sub-optimal to marginal conditions. With commercial scale production, marketing (that is, finding suitable outlets for one's produce) becomes a major factor as the produce is usually highly perishable and prices obtained by the grower may fluctuate considerably, their being no price control, no quotas etc. and therefore fairly frequent surpluses. The home gardener basically grows vegetables to satisfy some or all of the domestic needs and would prefer to have a small but regular supply of vegetables.

The terms of reference for this study require only an indication of the potential for various crops at Scenery Park. We were not requested to recommend the type of production unit ie. whether commercial production, community gardens, or home gardens.

3.2.1.1 Soil requirements

Adequate rooting depth, drainage and aeration of a soil are basic requirements for vegetable crops. The depth of rooting of vegetables is influenced by the soil profile. If there is a clay pan, hard pan, compacted layer, or other dense formation, the normal depth of rooting is not possible. Also where there is a high water table. What are the characteristic rooting depths of various vegetables? Lorenz and Maynard (1980) distinguish between shallow-rooted, moderately deep-rooted and deep-rooted crops (see Table 3.5). Peckover (1984) distinguishes between vegetables having a small shallow root system (eg. onion, beetroot, carrot and radish - down to 30 cm), those with a spreading shallow root system - 60 cm down, 200 cm across), a hemispherical root system (eg. tomato, cabbage, bean, egg-plant and pepper - 60 to 90 cm) and those with a deep root system (eg. rhubarb - down to 300 cm and more). Actually, this is not too important. Obviously the deeper the soil the better it is, the greater the moisture and nutrient reserves and the fewer the problems to be expected. For commercial production (with mechanization) a minimum depth of 50 cm would be desirable. For small-scale production raised beds may be made so that even shallower soils can be utilized satisfactorily, soils as shallow as 30 cm. Several organisations recommend trench beds of various descriptions for home gardens.

Table 3.5 Characteristic rooting depths of various vegetables (after Lorenz and Maynard, 1980)

Shallow (45 to 60 cm)	Moderately Deep (90 to 120 cm)	Deep (More than 120 cm)
Broccoli	Bean, bush	Artichoke
Brussels sprouts	Bean, runner	Asparagus
Cabbage	Beetroot	Bean, Lima
Cauliflower	Carrot	Parsnip
Celery	Cucumber	Pumpkin
Chinese cabbage	Eggplant	Squash, winter
Garlic	Muskmelon	Sweet potato
Leek	Pea	Tomato
Lettuce	Pepper	Watermelon
Maize	Squash, summer	
Onion	Swiss Chard	
Potato	Turnip	
Radish		

Thompson and Kelly (1959) point out that where large-scale specialized vegetable production is concerned (and this may be quite a distance from the markets) good soils are generally preferred. On the other hand, "while vegetables for nearby markets are often produced on soil not well suited to their growth, the soils selected are usually the best available. In this case nearness to markets may offset the disadvantages of ill-adapted soils, provided other conditions are favourable". However, with respect to Scenery Park it must be remembered that we are not dealing with experienced vegetable growers. Also one needs to bear in mind the fact that they would be competing for markets with long-established growers around East London and further afield. Furthermore, one does not wish to promote improper or inappropriate land use or land use practices which would be irresponsible.

Our survey of Scenery Park has indicated the presence of a relatively small area of soils with a moderate to good potential for irrigated cropping. Any commercial vegetable cropping would have to be confined to these soils. On the other hand, if the area is to become a major settlement project, local residents could also establish home gardens on the less suitable soils but not on those with serious limitations.

3.2.1.2 Climatic requirements

Most vegetables can be grown successfully around East London, particularly as there is no frost. Since most vegetables are not grown as perennials, but as annuals, it is possible to grow them during a period of the year which best meets their requirements in terms of temperature and, in some cases eg. with onion, daylength or photoperiod. The important climatic requirements of a range of vegetable crops are listed in Table 3.6. All the vegetables appreciated by the black communities in the area can be grown successfully. This represents a relatively small, though increasing, range of vegetables.

A classification system such as that of Ehlers (1974), is of limited value in determining the range of vegetable crops that can be grown. It is more useful for perennial crops or for deciding when to grow vegetable and field crops. A guide to suitable planting times for various vegetable crops is provided (Table 3.7). By carefully selecting the most appropriate cultivars for a particular time of the year an extended supply period can be assured. Seed companies and other seed suppliers in the area will be able to provide useful information in this regard. There is also no substitute for experience of local conditions, practices, and preferences.

Climate is the most important factor in determining the regions of production of vegetables and with modern transport facilities distance from markets is no longer a major consideration. Vegetables are transported over long distances from the Transvaal Lowveld and from irrigation schemes along the Vaal and Orange Rivers, for example. The local vegetable growers have to compete with these large, specialist producers. They must therefore confine their efforts largely to those crops for which the climate and conditions are most favourable.

Rainfall and atmospheric humidity are other considerations, the former mainly where water for irrigating is limited, the latter mainly from a point of view of vegetable diseases.

TABLE 6. CLIMATIC RANGES OF VEGETABLES

Crop	Germination (soil temperature)	Days to maturity	Notes
I. Cool season crops			
A. Optimum 16°–18°C (60°–65°F), intolerant of monthly mean above 24°C (75°F), some tolerance to freezing			
Spinach	4°–16°C (40°–60°F)	35–40	Long day and high temperature induces bolting
Beet	10°–30°C (50°–85°F)	50–70	Below 10°C (50°F) bolting induced; high temperature, zoning of red pigment
Parsnip	10°–24°C (50°–75°F)	100–130	Below 10°C (50°F) bolting induced
Turnip	10°–35°C (50°–95°F)	40–60	
Cabbage	10°–30°C (50°–85°F)	30[a] + 60–110	Below 7°C (45°F) bolting induced
Radish	10°–30°C (50°–85°F)	21–30 summer 56–60 winter	
Broccoli	10°–30°C (50°–85°F)	30[a] + 60–110	
Also: Brussels sprouts, kale, rutabaga, collard, kohlrabi, salsify, watercress, broad bean, rhubarb			
B. Optimum 16°–18°C (60°–65°F), intolerant of monthly mean above 24°C (75°F), damaged by freezing weather (more easily near maturity)			
Cauliflower	10°–30°C (50°–85°F)	30[a] + 55–150	
Pea	10°–30°C (50°–85°F)	55–75	
Swiss chard	10°–30°C (50°–85°F)	50–60	
White potato (tubers)	7°–27°C (45°–75°F)	90–110	Short day, low temperature induces tubers
Celery	10°–24°C (50°–75°F)	80[a] + 80–130	Below 10°C (50°F) bolting induced
Carrot	10°–30°C (50°–85°F)	60–85	Below 10°C (50°F) bolting induced
Lettuce	4°–27°C (40°–80°F)	40–100	High temperature and possibly long day induce bolting
Also: endive, globe artichoke, cardoon, celeriac, chicory, Chinese cabbage, fennel, parsley, mustard			
C. Optimum 18°–30°C (65°–86°F), tolerant of frost			
Onion	10°–30°C (50°–86°F)	90–250	Bulbing day length sensitive below 10°–16°C (50°–60°F) bolting induced
Asparagus	16°–30°C (60°–86°F)	Perennial	Tips of shoots are injured at temperatures below freezing
II. Warm season crops			
A. Optimum 18°–30°C (65°–85°F), intolerant of frost			
Sweet corn	16°–35°C (60°–95°F)	65–100	
Snap bean	16°–30°C (60°–86°F)	45–75	Seedlings subject to chilling injury below 10°C (50°F)
Lima bean	21°–30°C (70°–86°F)	65–90	Seedlings subject to chilling injury below 10°C (50°F), no fruit set in low humidity
Tomato	16°–30°C (60°–86°F)	50[a] + 60–100	No fruit set in low humidity
Pepper	16°–35°C (60°–95°F)	50[a] + 60–85	Seedling and fruit subject to chilling injury below 10°C (50°F); no fruit set in low humidity
Cucumber	16°–35°C (60°–95°F)	50–75	Seedlings and fruit subject to chilling injury below 10°C (50°F)
Muskmelon	21°–32°C (70°–90°F)	80–120	Seedlings subject to chilling injury below 10°C (50°F)
Also: summer squash, winter squash, pumpkin, chayote, New Zealand spinach, roselle			
B. Long season, will not thrive below 21°C (70°F)			
Watermelon	21°–35°C (70°–95°F)	70–95	
Sweet potato (roots)	21°–32°C (70°–90°F)	40[a] + 150	Chilling injury below 10°C (50°F)
Eggplant	21°–35°C (70°–95°F)	50[a] + 75–85	
Okra	21°–35°C (70°–95°F)	50–60	

(Continued)

TABLE 6. *(continued)*

Source: Revision of MacGillivray (1953).

[a] Days to grow transplants in nursery or in plant beds.

Table 3.7 General sowing guide for vegetables in the East London area

Crop	Time
Baby Marrow	Late winter to early autumn
Bean, green	Late winter to early autumn
Beetroot	All year round
Broad Bean	Autumn
Broccoli	Late summer to winter and selected cultivars in spring
Brussels Sprouts	Late summer and autumn
Cabbage	All year round, depending on correct choice of cultivars
Carrot	All year round
Cauliflower	See broccoli
Celery	Late winter, spring and autumn
Chinese Cabbage	Late summer to winter
Cucumber	Late winter to mid-summer
Egg Plant	Spring to summer
Kale	As for broccoli
Leek	Late summer and autumn
Lettuce	All year round, depending on correct choice of cultivar
Maize	Late winter to mid-summer
Onion	Late summer and autumn, depending on cultivar
Pea, green	Autumn and early winter
Pepper (capsicum)	Spring to mid-summer
Potato	Late winter/spring and mid-summer
Pumpkin	Late winter to summer
Radish	All year round except mid-summer
Squash	As for pumpkin
Sweetcorn	Late winter to mid-summer
Swiss Chard	Spring and late summer/autumn
Tomato	All year round except winter
Watermelon	Late winter and spring

Wind is a problem in coastal areas and for this reason windbreaks can be used to good effect. Napier fodder is especially popular and would be strongly recommended if substantial intensive crop production were to take place at Scenery Park.

3.2.1.3 Narrowing down the range of suitable vegetable crops

Soil and climatic conditions prevailing at Scenery Park are unlikely to severely curtail the range of vegetable crops that can be grown there. It is most likely that local growers would produce the crops they are familiar with and appreciate the most. It would also be wise to consider those crops which have lower risks in terms of adaptability, pests and disease, and those which are not too expensive to produce.

Brutsch (1984) conducted a survey of vegetable growing and consumption in the Amatola Basin of Ciskei. The most popular vegetables, in terms of general consumption were: tomato, cabbage, potato, Swiss chard (spinach), onion, pumpkin, carrot and beetroot. There was little or no consumption of sweet potato, lettuce, other brassicas and other cucurbits. Black urban and peri-urban populations around East London would be expected to have very similar consumption patterns, although probably more diverse. For example, sweet potatoes and lettuce would be more popular. The frost-free climate would ensure a supply of planting material (stem cuttings or tubers) for sweet potatoes.

Strydom and Oosthuizen (1979) compared fifteen vegetables as potential food crops. They showed that vast differences exist in their ability to contribute substantially towards food production. Carrot, sweet potato, cabbage, beetroot and pumpkins took the top five places in a combined ranking based on energy and protein production, and the "risk hazard" attached to their production. The above crops, with the exception of sweet potato, are also crops which were found to be very popular with the Xhosa people of the Amatola Basin, in terms of both production and consumption.

Brutsch (1989) indicated the important role of vegetables in the human diet and suggested how existing crops (eg. beetroot) and "new" crops (eg. kale and turnips) could further contribute towards improved diets amongst the Xhosa people. It is doubtful that people would be greatly motivated to grow a crop purely on the basis of its nutritional value. It must be socially acceptable. Most important perhaps is the prospect for success in growing a particular vegetable, in other words, the "risk hazard" must be relatively low. Although the tomato is very popular, it is difficult to grow successfully because of the greater risks associated with pests and diseases. A summary of the relative rankings of fifteen vegetables for energy and protein production is presented in Table 3.8. Also indicated are comparative yields, which tend to be rather conservative but perhaps are appropriate for less-developed agriculture. Table 3.9 indicates risk values pertaining to the extent of production problems of the fifteen vegetable crops. The relative importance of these factors in the East London area may differ somewhat from the value indicated, because of the conditions prevailing here. For example, the Spotted Wilt Virus of tomatoes is particularly prevalent and severe in the Eastern Cape. Fortunately at least one tolerant cultivar ('Stevens') is available. (Unfortunately Table 3.8 and 3.9 do not include Swiss Chard which would, however, rate well).

The sweet potato is an outstanding crop in most respects but tends to be underestimated and needs to be grown much more extensively (see Brutsch, 1989).

What is important in the above comparisons is not so much the actual ratings (some of which may be contentious, as indicated above) but the awareness created of the different factors to consider. Obviously to the commercial grower such factors as Gross Margin per hectare or Gross Margin per R100,00 of variable costs would be overriding considerations. Marketing, it is worth repeating, is one of the major concerns of the commercial vegetable grower. Potential commercial vegetable growers

Table 3.8 Summary of yields and relative rankings of 15 vegetables for energy and protein production and risk hazard (Strydom and Oosthuizen, 1977)

Crop	Crop Yield tonnes/ha*	Energy** production	Protein** production	Risk*** hazard	Total ****
Carrot	25	3	4	1	8
Sweet potato	30	1	1	7	9
Cabbage	30	6	2	3	11
Beet	20	4	6	1	11
Pumpkin and Squash	20	5	7	7	19
Peppers (green)	20	8	8	4	20
Onions	25	9	9	10	21
Brussels sprout	8	3	3	10	22
Tomato	30	5	5	15	27
Broccoli	8	11	12	4	29
Beans (green)	8	10	10	10	30
Lettuce	15	11	13	7	31
Asparagus	3	15	15	4	34
Cauliflower	15	12	11	13	36
Peas (green)	3	14	14	13	41

* Conservative yields. Potential yields much higher under good management
** The highest numerical value denotes the lowest production
*** The highest numerical value denotes the highest risk
**** Excluding yield

Table 3.9 Riskfactor values* pertaining to the extent of production problems of fifteen vegetable crops (Strydom and Oosthuizen, 1977)

Crop	Disease problems	Pest Problems	Sensitivity to adverse weather etc.	Adaptability to climatic regions and planting times	Total
Asparagus	1	2	2	2	7
Beans (green)	3	1	3	2	9
Beet	1	1	1	1	4
Broccoli	1	3	1	2	7
Brussels Sprout	1	3	2	3	9
Cabbage	1	3	1	1	6
Carrot	1	1	1	1	4
Cauliflower	3	3	3	3	12
Lettuce	2	1	3	2	8
Onion	3	2	2	2	9
Peas (green)	2	2	4	4	12
Pepper (green)	2	1	2	2	7
Pumpkin and Squash	3	2	2	1	8
Sweet Potato	1	2	1	4	8
Tomato	5	4	3	1	13

* Arbitrary values determined by a panel of four vegetable specialists
1 = low risk
5 = extremely high risk

Table 3.10

SOIL REQUIREMENTS FOR SUBTROPICAL CROPS

Crop	Soil depth (m)			Clay + Silt content (%)			Soil colour		Factors which may limit the production or lifespan of the crop	The suitability of soil types	
	Optimal	Marginal	Unsuitable	Optimal	Marginal	Unsuitable	Optimal	Marginal		Optimal	Marginal
CITRUS Valencia/Rough lemon	>1,0	0,5-1,0	<0,4	10-25	25-35 5-10	<5 and >35	Red or brown	Grey or Yellowbrown	Hard layers limit root development, compacted and plinthic layers root development and drainage	Hutton, Oakleaf	Fernwood, Clovelly
Valencia/Troyer	>0,8	0,5-0,8	<0,4	20-35	10-20	<10 and >40	Red or brown	-	"	Hutton, Oakleaf	Swartland
Navel	>1,0	0,5-1,0	<0,4	10-30	30-35 5-10	<5 and >35	Red or brown	Grey	"	Hutton, Oakleaf	Fernwood, Clovelly
Grapefruit and lemon	>1,0	0,5-1,0	<0,4	10-40	5-10	<5 and >40	Red or brown		"	Hutton, Oakleaf	Fernwood, Clovelly Swartland Shortlands
Avocados	>1,5	1,2-1,5	<1,2	20-40	40-50 and 15-20	<15 >50	Bright red	Red or brown	Poorly permeable, hard or compacted layers inhibits drainage, promotes root rot and consequently seriously shortens the lifespan of trees	Hutton	-
Bananas	>0,8	0,6-0,8	<0,5	25-50	-	<20 and >60	Red or brown		Soils should have an adequate water-holding capacity	Hutton, Bainsvlei Shortlands	Swartland, Oakleaf
Pineapples	>0,6	0,4-0,6	<0,4	5-40	0-5 and 40-50	>50	Not important		Soils with restricting layers at shallow depths could cause waterlogged conditions. Soil climate is important – drought symptoms may occur in dry years on sandy or clayey soil	Glenrosa, Fernwood, Clovelly, Oakleaf, Hutton Shortlands	Mispah, Bonheim Swartland
Papayas	>0,6	0,4-0,6	<0,4	5-40	40-60	>60	Not important		Waterlogged conditions cause fruit-drop. Poorly drained layers or slow infiltration of water would therefore be inhibiting	"	"
Mangoes	>1,0	0,6-1,0	<0,5	10-50	-	>60	Not important		Very dry or wet conditions have a negative influence on production. Soils should therefore have a satisfactory water-holding and drainage capacity	"	"
Guavas	>0,8	0,6-0,8	<0,4	5-40	40-60	>60	Not important			"	"
Granadillas	>0,6	0,4-0,6	<0,4	5-40	40-50	>50	Not important		The upper soil layers should be well drained with a reasonable water-holding capacity	"	"
Litchis	>1,0	0,8-1,0	<0,6	5-25	25-35	>35	Red, grey or brown	Dark	Temporary dry or wet conditions influence production capacity	Hutton, Fern-Oakleaf	Clovelly
Pecan nuts	>2,0	1,5-2,0	<1,0	10-30	30-40	>40	Red and brown	Dark	Deepgrowing tap roots should be able to develop unrestricted. Hard or compacted layers are therefore restrictive	Oakleaf	Hutton, Bainsvlei
Macadamia nuts	>1,0	0,8-1,0	<0,8	15-30	30-45and 5-15	>45	Red, grey or brown	Yellow-brown or dark	Hard and plinthic layers restrict root development and moisture movement	Hutton	Oakleaf, Fernwood Clovelly

REMARKS

1. Soil depth – Is considered as the effective rooting depth. That is the depth of soil on to a solid or impermeable layer. Weathered, gravelly soil is therefore deeper than the upper buurdz of occurence of the gravel

2. Clay content – The significance of this characteristic is also influenced by the type of clay material present. Dark, swelling clays may restrict root development more than well-drained red clays

3. Water-holding capacity – If large amounts of gravel stones occu in the soil profile, a greater soil depth will be required for an accept ble water-holding capacity. Irrigation practices must therefore be ad ted on gravelly soils

should first of all find markets before considering growing a crop. The technical know-how to grow most vegetable crops is readily available. Management levels and marketing are the major factors determining the success of a vegetable-growing enterprise. Considerable cost savings to the grower can be achieved if vegetables (eg. cabbages and pumpkins) are collected by the buyer on the farm, thus obviating transport costs, market and agent fees and, sometimes, costs of bags for the produce. There is also an advantage in growing crops that are less perishable and can be stored for shorter or longer periods (eg. potatoes, onions, pumpkins).

Other than soil and climatic conditions, there are numerous other factors to consider before committing oneself or a project to vegetable production, particularly on a commercial scale. For example, it is possible to grow a large number of vegetable crops on the irrigation schemes of Ciskei and Transkei but how much success has there been? Very little, and many failures!

3.2.2 FRUIT CROPS

In addition to the Ehlers classification of agro-ecological sub-regions and the classification by Wolstenholme (1977) for tropical and sub-tropical climates and fruit crops, one can also consider the following:

(i) the suitability of soil for the cultivation of sub-tropical crops (Nel, 1982). Refer to Table 3.10.

(ii) the choice of (tropical and sub-tropical) crops (Joubert, 1982) based on prevailing temperature, relative humidity and rainfall, and assuming supplementary irrigation where necessary. Refer to Appendix 3.

Also available for further particulars of each crop are the numerous information leaflets produced by the Director of Information (Dept. of Agriculture of RSA), Private Bag X144, Pretoria.

3.2.2.1 Soil requirements

As in the case of vegetables, commercial production of fruit crops would require the selection of near - optimal conditions, including soils. For small-scale production and/or with a high level of management and perhaps special economic incentives (strong local demand for a fruit at attractive prices to the grower) sub-optimal soils could be selected provided other factors are not severely limiting. For example, most pineapple growers plant on small ridges to improve drainage and aeration (and perhaps rooting depth where it is limiting). In the citrus-growing areas of Ciskei and the Eastern Cape midlands citrus is frequently planted on broad-based ridges to overcome soil limitations (as indicated above for pineapples).

In Table 3.10, Nel (1982) has indicated the important parameters or criteria for determining the suitability of soil for the cultivation of subtropical fruit crops. The degree to which a particular crop can grow, develop and produce in a soil type is dependent upon soil physical characteristics such as drainage, density, texture, moisture-retaining capacity, structure, homogeneity of the profile, erodibility, colour, depth and degree to which water can penetrate the soil (infiltration capacity).

The soils that were surveyed at Scenery park are mostly unsuitable or marginal for many fruit crops, except perhaps for home gardens. Oakleaf soils are suitable for most fruit crops. The Glenrosa soils and others with limited depth or restricted drainage (and aeration) are marginal for most crops. Guavas, papayas and granadillas could be grown on a Glenrosa soil with adequate depth and drainage.

Pineapples were apparently grown in the past at Scenery Park, but not very successfully, according to a verbal report made to us. There could be many reasons for this, including poor soils.

3.2.2.2 Climatic requirements

Wolstenholme (1977) stated that "a knowledge of the broad climatic and soil requirements of a crop, and of the essential ecological parameters of a particular locality is of use as a first step in land-use planning. Generalized extrapolations can be made from such data, but it must be stressed that the final arbiter is subsequent prudent site evaluation and selection within the broadly suitable area. In the final analysis, factors such as soil series, aspect, topography and exposure to wind will become increasingly important".

We have already discussed the soil potential of Scenery Park for sub-tropical fruit crops. On the basis of climate Wolstenholme (1977) suggested the following crops would be worth considering for a cool sub-tropical climate as experienced at East London: navel orange, avocado, granadilla and kiwi fruit (although for the latter colder winters are required). The climatic conditions are not considered optimum for pineapple for which he recommends a tropical to semi-tropical (as distinct from sub-tropical) lowland, maritime climate with medium rainfall and humid conditions.

Crops such as litchi, papaya, mango, loquat, macadamia nut, mulberry and fig could probably also be grown but under sub-optimal to marginal conditions. There are examples of success under such sub-optimum conditions. For example, Allan (1977) has demonstrated that advantage can be taken of the slower growth rate of the papaya in a cool sub-tropical, frost-free area such as Pietermaritzburg. Avocados are grown successfully at Riverside Farms near Fort Beaufort owing to a favourable micro-climate and outlets for the fruit. Economic success in such cases, Wolstenholme (1977) points out, is dependent on advanced management expertise and experience based on extensive research.

Apart from navel oranges, other citrus could certainly be grown with a fair degree or success on irrigated Oakleaf soils. For home gardens, Valencias, lemons and grapefruit. On a commercial scale possibly soft citrus eg. Satsumas and Clementines. The following are the climatic requirements, of soft citrus which differ somewhat from those of Valencias and grapefruit which are traditionally produced in areas with hotter summers (and winters).

Winter: Preferably frost-free but cold for good flower initiation and uniform flowering in spring; and for good colour development at maturity.
Spring: Absence of late frost and soil moisture stress.
Summer: Hot and sunny days with night temperatures preferably below 19°C.
Autumn: Hot days; cold nights favour good colour development of mature fruit.

Relatively dry winters are an advantage during harvest to reduce the incidence of oleocellosis.

Windbreaks would be necessary to reduce the adverse effects of wind on tree growth and fruit quality (especially wind between September and January).

However, production of soft citrus requires a good technical knowledge of the crop and a high level of management if the crop is to be successfully grown for export. It involves a high initial capital outlay but promises attractive gross margins. However, Satsumas from the Eastern Cape fetched very disappointing prices in Europe during the 1993 season, owing to certain circumstances.

3.2.2.3 General observations

The only two fruit crops that seem to be produced commercially in the vicinity of East London are guavas (relatively small scale) and pineapples. Production of soft citrus has increased dramatically in recent years in the Eastern Cape in traditional citrus areas but could well expand to other suitable areas near the coast. For example, highly promising new plantings have been made in the narrow coastal belt around Knysna and George.
An interesting possibility is the production of spineless prickly pears which are a much-relished fruit among the Xhosa people. The prickly pear (which we now prefer to call cactus pear) is drought-tolerant and relatively easy to grow and manage. There ought to be a large market for this fruit in the townships of East London.

The young cladodes may be eaten as a vegetable. Mature cladodes may be used to make soap and various processed foodstuffs such as chutneys and achar. The utilization of wild and spineless cactus is described by Brutsch and Zimmermann (1993). There is an active Cactus Pear Growers Association in South Africa (±180 members) and good prospects for exporting the fruit to European and other markets. We do not know of cactus pear orchards in the vicinity of East London and how the different cultivars would perform.

A potential problem with Scenery Park is its relative isolation and proximity to an extensive nature reserve. Monkeys and buck could do considerable damage to crops, even to cactus pears. Theft could be a problem although the isolated position of the farm could initially be an advantage.

Carr (1986) drew up a horticultural "crop selection sheet" (Appendix 4) on the basis of prevailing aspect, frost incidence, irrigation needs, soil depth, drainage and wind in Queensland, Australia. His selection criteria are also relevant to local conditions. Irrigation needs are indicated as megalitres (ML) per hectare.

Because of the perennial nature of most fruit crops it is not easy to go in or out of fruit production and a degree of commitment is required. Considerable expense may be involved in establishing orchards, packhouse facilities etc. Because fruit trees are perennial it is all the more important that they be grown under favourable conditions of soil and climate and that irrigation be available during often extended periods of drought. With vegetable crops, on the other hand, it is possible to select a period of the year when conditions can be expected to be favourable. A failure with a vegetable crop would normally not be as disastrous as with fruit trees.

Generally speaking, the prospects for the commercial growing of horticultural crops at Scenery Park seem to be rather limited, not so much from the point of view of physical factors as from the point of view of socio-economic factors and the fact that prospective agriculturists, if drawn from the local population, for the most part have little or no experience of horticultural crops. The growing of vegetables and field crops (possibly also cactus pear) would be less risky than the commercial production of most fruits.

3.3 ADDITIONAL INFORMATION FOR PLANNING OF VEGETABLE CROP ENTERPRISES

The intention is not to deal with the A to Z of each crop but to provide some information that may be used for planning purposes.

Much of the information will be provided in tabular form, and not for all vegetables. Some information is not readily available in published form or is not specific enough. Consider, for example, the Vegetable Sowing Chart of the Department of Agriculture which has one set of recommendations for the Eastern Cape and Southern Karoo. This is a vast area with moderate frost-free climates along the coast and cold to very hot climates inland.

3.3.1 SOWING TIMES AND CULTIVARS

The sowing times given for East London in Table 3.7 refer to the most suitable or optimum sowing or transplanting times. However, with the wide range of cultivars available to-day and with specific micro-climates it is possible to extend what is considered to be the "normal" growing season. The fact that there are now specialist seedling growers means also that a grower can buy in seedlings to be planted immediately conditions are favourable for a crop.

There is often no substitute for information that can be obtained in the area from suppliers of vegetable seed and seedlings and from leading farmers. One must produce a commodity that the market agent, the supermarket or the hawker will be able to sell. It is important therefore to be well informed in terms of planting times and most suitable cultivars.

3.3.2 APPLICATION OF FERTILIZERS AND ORGANIC MATTER TO VEGETABLE CROPS

Soil samples from Scenery Park have been analyzed and recommendations made to bring the nutritional status to a desirable level. It is then necessary to apply fertilizer in such quantities as to ensure a good crop and maintain the soil status at a desirable level.

Because of the numerous factors involved no specific recommendations are available for the East London area. In Appendix 5 general recommendations are made for South African conditions. Approximate nutrient removal figures for N, P, and K are presented in Table 3.11. Removal is related to crop yield. The higher the target or expected yield the more nutrients have to be applied. Mean and optimum crop yields are indicated in Appendix 6.

Target yield will depend on a number of factors including level of management. For the commercial growers it is necessary to adjust fertilizer applications for each crop since they produce on a more extensive scale and usually produce a small range of crops. For home or subsistence growers it would be confusing to vary rates for each different crop or groups of crops. For them we suggest they apply 1 000 kg per hectare (1 kg per 10 m2) of a readily obtainable 2:3:2 or 2:3:4 compound fertilizer, preferably with zinc. This quantity will be excessive for some crops and inadequate for others but should balance out over a period of time.

The use of organic matter, compost or manure, is to be encouraged. If relatively large quantities are used then the amount of inorganic or artificial fertilizer can be reduced. Not only does such organic matter provide nutrients for the crops but it also improves the condition of the soil and its moisture retention. Crusting of the surface is reduced and water infiltration is improved.

Some organisations are opposed to the use of "artificial" fertilizers and advocate the use of organic fertilizers only. We recommend both.

Table 3.11 Approximate nutrient removal from the soil by different vegetable crops (based on AVRDC, 1990)

Crop	Yield (t/ha)	Nutrient Removal (kg/ha) N*	P	K
Bean	12	80	15	85
Broccoli	50	220	45	190
Cabbage	70	250	40	265
Cauliflower	50	200	35	210
Celery	30	180	35	250
Cucumber	30	50	20	65
Onion	30	90	20	100
Pea	2	125	15	90
Potato	30	130	25	150
Radish	12	100	25	250
Tomato	40	110	15	125

* Legumes are able to obtain part of this nitrogen from fixed nitrogen

3.3.3 IRRIGATION

Water is the major component of most fresh vegetables - generally 90% by mass. Thus water or water management largely determines the yield and quality of vegetables. Many defects of vegetable produce may be traced directly or indirectly to mismanagement of water supply in the production field.

A good proportion of investment in vegetable growing is allocated for water management, whether on a large commercial scale with sprinkler or flood irrigation, or in home gardens or subsistence agriculture where water is applied by manual labour.

Critical growth stages for soil drought stress on several vegetables are indicated in Table 3.12. Excess water can also be a problem and vegetable crops differ in their sensitivity to such an excess.

Table 3.12 Critical growth stages for soil drought stress on several vegetables (AVRDC, 1990)

Crop	Critical Stage
Asparagus	Fern growth
Bean	Flowering and pod forming
Broccoli	Head forming and enlarging
Cabbage	Head forming and enlarging
Carrot	Root enlargement
Cauliflower	Adequate irrigation required from planting to harvest
Celery	Initial stage and during rapid growth (hot periods)
Cucumber	Flowering and fruit enlarging
Eggplant	Flowering and fruit enlarging
Lettuce	Head developing
Onion	Flowering and filling
Pepper	Transplanting, fruit setting, and developing
Potato	Any growth period from planting to harvest
Pumpkin	Flowering and fruit developing
Radish	Root enlarging
Squash	Flowering and fruit developing
Sweet corn	Tasselling, silking, and ear filling
Tomato	Flowering, fruit setting, and enlarging
Watermelon	Flowering to fruiting

The irrigation-water requirement of a crop is determined by consumptive use and irrigation efficiency. Consumptive use or evapotranspiration is the sum of transpiration and evaporation water lost to the atmosphere from soil and water surfaces and from plant surface. Consumptive use is influenced by weather conditions, irrigation practices, length of the growing season, stage of crop development, and other plant factors. The ratio (k) of consumptive use to evaporation (as measured with a standardised Class A Pan) is known as the crop factor and is usually any value between zero and one, depending on the stage of development and other factors mentioned above. Average seasonal values of k (or crop factors) vary from about 0,65 to 0,75.

If at a particular stage of development of the crop, the crop factor (as determined by research) is 0,9 and the pan evaporation is 7 mm per day, then consumptive use is 0,9 x 7 mm = 6,3 mm/day. If crop factors are not available for the different stages of growth of a crop, then one can use an average value of 0,65. If, for example, the growing period of a crop is 100 days from planting to harvest and evaporation from a Class A Pan is 520 mm then, using an average value of 0,65, consumptive use would have been in the region of 0,65 x 520 = 338 mm for the growing period of that crop.

A second factor however has to be considered in determining the quantity of water to apply to a crop, namely irrigation efficiency. It has three components: water application efficiency, water storage efficiency, and water distribution efficiency. Their relative importance will depend largely on the type of irrigation system used.

Irrigation-water requirement is equal to consumptive use of the crop divided by application efficiency. Using the above example of 338 mm for the cropping period and an efficiency of 65% for flood irrigation on a heavy soil, then the irrigation-water requirement will be 338/0,65 = 520 mm.

This tells us how much water is required for the crop, but not when to apply it. Good irrigation management requires knowledge and method of irrigation scheduling. The frequency and depth of water application are determined by water and soil conditions (depth and waterholding capacity mainly), the development stage of the crop, and depth of the root zone specific for the crop. Daily watering may be necessary for a newly seeded or transplanted crop in hot, dry conditions in sandy soils. Weekly waterings may be adequate for an established crop in cool damp weather and a heavy loam soil. It is a common fault to have frequent light applications that do not adequately wet the root zone but mislead the grower into believing that the crop is being adequately irrigated.

Intensive vegetable production at Scenery Park would require from 1 000 to 1 750 mm of irrigation-water per hectare per annum. Refer also to Appendix 4.

3.4 CROP ENTERPRISE GROSS MARGINS

The Gross Margin for an enterprise is calculated as the Gross Income less Allocated (or variable) costs. In Tables 3.13 and 3.14 Gross Margins are presented for various field crop, vegetable, and fruit crop enterprises in the Eastern Cape Region for areas with conditions similar to those prevailing at Scenery Park. None of the costings are based on enterprises in the East London area though.

The costings available are for July 1991. The purpose of presenting the costings is to compare enterprises in so far as relative costs and gross margins are concerned. We have also indicated Gross Margins per R100,00 of allocated (variable) costs.

Carrots	Sprinkler irrigation, Kruisrivier									
		tonne	449	30	11 774	5 796	193	5 978	199	103
Tomatoes	Flood irrigation in Sundays River Valley									
		tonne	869	60	52 151	36 821	614	8 811	147	24
Sweetcorn	Flood irrigation in Sundays River Valley									
		tonne	275	10	2 750	1 485	148	1 265	127	85
Broccoli	Flood irrigation in Sundays River Valley									
		tonne	1 665	7	11 156	2 938	438	8 218	1 227	280
Cauliflower	Flood irrigation in Sundays River Valley									
		tonne	397	18	7 146	2 984	166	4 162	231	139
Kikuyu	Dryland, Alexandria									
establishment		tonne				1 052				
after establishment		tonne				615				

* Levies deducted, where applicable

Navel Oranges	Flood irrigation in the Sundays River Valley									
1st yr	(price per tonne depends on grade of fruit and whether for export or local market)					8 563				-86
Yrs 2-3						1 234				-12
Yrs 4-7		tonne	348-815	19,1	12 224	3 956	207	8 268	433	209
Yrs 8-18		tonne	348-815	35,98	23 045	5 438	151	17 607	489	324
Yrs 19-25		tonne	348-815	21,47	13 751	5 127	238	8 623	401	168
Lemons	Flood irrigation in the Sunday River Valley									
1st yr	(Price per tonne depends on grade of fruit and whether for export or local market)					8 151				-82
2nd yr						1 042				-10
Yrs 3-7		tonne	382-726	24,74	15 249	3 958	161	11 291	459	285
Yrs 8-14		tonne	382-726	50,05	30 896	6 604	132	24 292	485	368
Yrs 15-20		tonne	382-726	31,77	19 610	6 036	190	13 574	427	225

less. Wind and breezes are a feature of the area but the valley may be more protected than the higher-lying surrounding land.

As can be seen from Table 3.15, no part of the farm can be said to have a distinctly high potential for irrigated cropping (and, for that matter, dryland cropping). For Area 1 only 18,8% of the total area of 36,61 ha has a moderate to good potential, with rooting depth and drainage being minor limitations. About 41% of the area is considered marginal to very marginal due to major drainage and rooting depth limitations. About 40% of the area is considered unsuitable. Area 1 is considered to be the best of the three areas in terms of location and potential.

Table 3.15. Suitability rating of Scenery Park soils for irrigated cropping.

Surveyed area and extent	% of total area surveyed	Suitability for irrigated cropping
1 (36,61 ha)	18.8 41.1 40.1	moderate to good marginal not suitable
2 (26,54 ha)	9.5 26.3 64.2	moderate to good marginal not suitable
3 (11,32 ha)	4.2 51,2 44,6	moderate marginal not suitable

Area 2 is the worst area in terms of the suitability of soils, with about 64% of the soils considered to be unsuitable for irrigated cropping and only 9,5% having moderate to good potential. The total area consists of 26,54 ha.

Area 3 (11,32 ha) gives the superficial impression of being suitable, lying as it does close to the Buffalo River on a horse-shoe bend. However, only 4,2% of the area has a moderate potential; 51,2% has a marginal potential and 44,6% is not suitable. The poor growth of the *Eucalyptus* trees on this land reflects this unexpectedly poor potential.

The potential for dryland cropping, based on soil potential, is very similar to that for irrigated cropping.

Because of these limitations mainly, but also for various other reasons previously mentioned, we would be hesitant to recommend the commercial production of irrigated fruit tree crops although for home gardens the following could be grown with various degrees of success depending upon suitability of soils (Refer to Table 3.5) and the care given to them:

Guava
Pineapple
Granadilla
Papaya
Citrus - various
Loquat
Fig
Prickly pear
(Macadamia nuts, although largely unknown)
Avocado (only on deep, well drained soils)

Obviously all these fruit crops would grow best on the deeper soils with better potential.

Vegetable crops could be grown commercially on all soils with a moderate to good rating and for home gardens also on the more marginal soils, possibly on raised beds to improve effective rooting depth and drainage. Production on a commercial scale would necessitate careful management of irrigation.

We did not have the opportunity to investigate the soils for harmful nematodes which would further reduce the cropping potential of the arable lands. This should be done. Although it is possible to treat soil for nematodes it is an expensive and difficult treatment and it is rarely possible to eliminate the problem altogether, particularly if a form of urban agriculture is to be practised. Nematodes such as the rootknot nematode are harmful to most crops.

As previously stated, there is a wide range of vegetables that could be produced but it is recommended that if a decision is made to grow them on the farm, on whatever scale, they should be selected on the basis of preferred vegetables, those for which there is a ready market and those which are grown most successfully with available resources.

The wild animal hazard and theft should not be underestimated. Many garden projects start with much enthusiasm but are not sustained because of the lack of proper motivation or because of overwhelming difficulties and discouragement. The keeping of livestock is also not very compatible with cropping enterprises unless the two can be effectively separated.

There are many conservationists who would argue strongly that the Scenery Park area should not be developed for intensive human habitation and utilization and they would maintain that to settle it would endanger the pristine forest reserve adjoining Scenery Park. At the very least one would expect that a thorough study of the impact of such a settlement project on the ecology of the area would be undertaken by competent experts. This was not a term of reference for this investigation by ARDRI.

If a decision is taken to settle and cultivate the area then all reasonable measures should be taken to ensure proper conservation of natural resources, in the broadest sense, and sustainability. If human and livestock pressures on the land are not controlled rapid deterioration of the land will ensue, with possibly uncontrollable consequences for adjoining areas, many of which include extensive and rare tracts of indigenous vegetation.

LIST OF ADAPTED CROPS IN AGRO ECOLOGICAL REGIONS (AFTER EHLERS)

CROP		TEMPERATURE REGIONS (SUMMER) 25	35	36	46	47	56	57	66	67	77	78	87	88	89	99	FROST FREE AREAS None	A	B	C	*WINTER CODE	**RE= MARKS
Almonds					◕	◕	◕	◕	◕	◕	◕	◕					●	●			46	
Apple			●	●	●	●	●	●	◑	◑	◐	◐					●				14	
Apricot							◑	◑	●	●	●	●	◑	◑	◑	◐	●				25	
Artichoke Globe + Jerusalem					●	●	●	●									●	●	●			FF
Asparagus			●	●	●	●	●	●	◕	◕	◕	◕					●	●	●	●	25	
Avocado								◕	●	●	●	●	◕	◕	◕	◕		●	●	●	35	
Banana											●	●	●	●	●	●		●	●	●		FF
Barley					◑	◑	●	●	●	●	●						●	●			35	
Beans	Small Butter				●	●	●	●									●	●	●			FF
	Large Butter				◕	◕	◕	◕	[illegible]	[illegible]	◕	◕					●	●	●	●		FF
	Lablab				◑	◑	◑	◕	◕	●	●	●	◑	◑	◕	◕	●	●	●	●		FF
	Lima Large				◕	◕	◕	◕	◕	◕	◕	◕					●	●	●	●		FF
	Lima Small				●	●	●	●									●	●	●			FF
	Mung				●	●	●	●	●	●	●	●	◕	◕	◕	◕	●	●	●			FF
	Pigeon Pea										◕	●	●	●	●	●	●	●	●	●		FF
	Sword										◕	◕	◕	◐			●	●	●	●		FF
	Broad Bean										●	●	●	●			●	●	●			FF
	Dolichos Bean				◑	◑	◑	●	◑	●	●	●	◑	◑	◑	◑	●	●	●	●		FF
	Tepary										◕	◕	◐	◕			●	●	●	●		FF
	Velvet Bean										◕	◕	◕	◕	◕	◕	●	●	●	●		FF
Phaseolus vulgaris					◑	●	●	●	●	◑	◑						●	●	●			FF

◐ Marginal ◑ Sub-optimal ● Optimal ◕ Quite probable ⊖ Possible Frost Free

* WINTER CODE: This column indicates optimal winter temperatures more specifically

** FF: indicates that Frost Free conditions are required during growth.

P. vulgaris : Sub optimal if mean Max > 30°C

LIST OF ADAPTED CROPS IN AGRO ECOLOGICAL REGIONS (AFTER EHLERS)

CROP	TEMPERATURE REGIONS (SUMMER) 25	35	36	46	47	56	57	66	67	77	78	87	88	89	99	FROST FREE AREAS None	A	B	C	WINTER CODE	RE= MARKS
Beetroot				●	●	●	●	◐	◐							●	●	●			FF
Bixa Orellana										◐	◐	●	●	●	●	●	●	●	●	46	FF
Broccoli		●	●	◐	◐	◐	◐									●	●	●			FF
Brussel sprouts				●	●	●	●									●	●	●			FF
Buck wheat		◐	◐	●	●	◐	◐									●	●	●			FF
Cabbage				●	●	◐										●	●	●			FF
Carrots	◐	◐	◐	●	●	●	●	◐	◐							●	●	●			FF
Cassata										◐	◐	◐	◐	◐	◐		●	●	●	46	FF
Castoroil										◐	◐	●	●	●	●	●	●	●	●		FF
Cauliflower	◐	◐	◐	●	●	◐	◐									●	●	●			FF
Celery				●	●	●	●									●	●	●			FF
Cherry			●	●	◐	◐	◐									●				14	
Chicory				●	●	●	●	◐	◐							●	●	●			FF
Chinese Cabbage				●	●	●	●									●	●	●			FF
Citrus : Grapefruit													◐	◐	◐			●	●	46	FF
Mandarin												◐	◐	◐	◐		●	●	●	35	FF
Navalorange										◐	●	●				●	●			25-35	
Tangarine Orange										◐	◐	◐				●	●	●		25-35	
Satsuma									◐	◐						●	●			25-35	
Valencia												●	●	◐	◐	●	●			35-46	
Cotton										◐	◐	●	●	●	●	●	●	●	●		FF

LIST OF ADAPTED CROPS IN AGRO ECOLOGICAL REGIONS (AFTER EHLERS)

CROP	TEMPERATURE REGIONS (SUMMER) 25	35	36	46	47	56	57	66	67	77	78	87	88	89	99	FROST FREE AREAS None	A	B	C	WINTER CODE	RE= MARKS
Coffee Arabia							●		●	⊕	⊕						●	●	●		FF
Robusta													⊕	●	●			●	●	46	FF
Kohlrabi						◑	◑									●	●	●			FF
Colocasia antiquorum											◕	◕	◕	◕	◕			●	●		FF
Coriander								◑	◑							●	●	●			FF
Cowpeas				●	●	●	●	●	●	●	●	●	◕	◕	◕	●	●	●	●		FF
Cucumber								●	●	●	◕	◕				●	●	●	●		FF
Custard apple												●	◕	◕	◕			●	●		FF
Dhal											●	●	●	●	●		●	●	●		FF
Eggplant								●	●	●	●	●	●	●	●	●	●	●	●		FF
Endive				●	●	◑	◑									●	●	●			FF
Fig							◕	◕	◕	◕	◕	◕	◕	◕	◕	●	●	●	●	35	
Flax				●	●	●	●									●	●	●			FF
Garlic		●	●	●	●	●	●	●	●	●	●					●	●				FF
Ginger											◕	◕	◕	◕	◕			●	●		FF
Granadilla Yellow											◕	◕	◕	◕	◕		●	●	●		FF
Purple							◕	◕	◕	◕	◕						●	●	●		FF
Grapes		⊕	⊕	⊕	●	●	●	●	●	●	●	⊕	⊕	⊕	⊕	●	●			35	
Groundnut									◕	◕	●	●	●	●	◕	●	●	●	●		FF
Groundnut Bambara											◕	◕	◕	◕	◕		●	●	●		FF

LIST OF ADAPTED CROPS IN AGRO ECOLOGICAL REGIONS (AFTER EHLERS)

CROP	TEMPERATURE REGIONS (SUMMER) 25	35	36	46	47	56	57	66	67	77	78	87	88	89	99	FROST FREE AREAS None	A	B	C	WINTER CODE	RE= MARKS
Guava										◕	◕	◕	◕	◕	◕		●	●	●		FF
Horseradish				●	●	●	●									●	●	●			FF
Hubbard Squash					◕	◕	◕	◕	◕	◕	◕					●	●	●	●		FF
Japanese Radish				◕	◕	◕	◕	◕	◕							●	●	●			FF
Kaffir watermelon								◕	◕	◕	◕	◕	◕	◕	◕	●	●	●	●		FF
Kale				●	●	●	●									●	●	●			
Kumquat										◕	◕	◕	◕			●	●	●		35-46	
Leek		●	●	●	●	●	●	●	●	●	●					●	●	●	●		FF
Lettuce	◑	◑	◑	●	●	◑	◑									●	●	●			FF
Lentil				◕	◕	◕	◕	◕	◕							●	●	●			FF
Litchi										◑	◑	●	●	●	●		●	●	●	46	FF
[illegible]				◑	◑	◑	●	●	●	●	●	●	●	●	◑	●	●	●	●		FF
Loquat						◑	●	◑	●	●	◑					●	●	●	●	35	
Lucerne		●	●	●	●	●	●	●	●	●	●	●	●			●	●	●			FF
Macadamia									●	●	●	●	●	◑	◑		●	●	●		FF
Ma[illegible]e				◑	◑	◑	●	◑	●	●	●	◑	◑	◑		●	●	●	●		FF
Mangle				◕	◕	◕	◕	◕	◕	◕	◕					●	●	●	●		FF
Manihot Spp.											◕	◕	◕	◕	◕			●	●	46	FF
Manga										◕	◕	◕	◕	◕	◕		●	●	●	46	FF
Muskmelon						●	●	●	●	●	●	●	◑	◑	◑	●	●	●	●		FF

LIST OF ADAPTED CROPS IN AGRO ECOLOGICAL REGIONS (AFTER EHLERS)

CROP	TEMPERATURE REGIONS (SUMMER) 25	35	36	46	47	56	57	66	67	77	78	87	88	89	99	FROST FREE AREAS None	A	B	C	WINTER CODE	RE= MARKS
Mustard				●	●	●	●									●	●	●			FF
Oats		◐	◐	●	●	●	●	●	●	◐						●	●	●		35	
Okra								◐	◐	◐	◐	◐	◐	◐	◐	●	●	●	●		FF
Onions		●	●	●	●	●	●	●	●	●	●					●	●	●	●		FF
Parsely				●	●	●	●									●	●	●			FF
Parsnips				●	●	●	●									●	●	●			FF
Papaya									◐	●	●						●	●	●		FF
Peach				◐	◐	◐	◐	◐	◐	◐	◐	●	●	●	◐	●	●			25	
Pear				◐	◐	◐	◐	◐	◐	◐	●	●	●	●	◐	●				24	
Peas		◐	◐	●	●	◐	◐									●	●	●	●		FF
Pecan nuts									◐	●	●	●	●	◐	◐	●	●			35	
Peppers Sweet							●	●	●	●	●					●	●	●	●		FF
Hot								●	●	●	●	●	●	●	●	●	●	●	●		FF
Persimmon							◐	●	●	●	●	◐	◐			●	●	●	●	25	
Phormium tenax						●	●	●	●							●	●	●		15	FF
Pimiento										◐	◐	◐	●	●	●	●	●	●	●		FF
Pineapple									●	●	●	●	●	●	◐		●	●	●	36	FF
Plum European		●	●	●	●											●	●			25	
Japanese		●	●	●	●											●	●			25-35	
Potato			◐	●	●	●	●	◐	◐							●	●	●			FF

LIST OF ADAPTED CROPS IN AGRO ECOLOGICAL REGIONS (AFTER EHLERS)

CROP	TEMPERATURE REGIONS (SUMMER) 25	35	36	46	47	56	57	66	67	77	78	87	88	89	99	FROST FREE AREAS None	A	B	C	WINTER CODE	RE= MARKS
Pumpkin						●	●	●	●	●	●	◐	◐			●	●	●	●		FF
Pyrethrum				●	●	●	●									●	●	●		35	
Quince								◐	◐	◐	◐	◐	◐	◐	◐	●	●	●	●	35-46	
Radish				●	●	●	●									●	●	●			FF
Radish Japanese				◐	◐	◐	◐	◐	◐							●	●	●			FF
Rhubarb				●	●	●	●									●	●	●		14	
Rice												◐	●	●	●	●	●	●	●		FF
Ricebean											●	●	●	◐	◐	●	●	●	●		FF
Rye		◐	◐	●	●	●	●	●	◐	◐						●	●	●	●	35	
Shallot		●	●	●	●	●	●	●	●	●	●					●	●	●	●		FF
Sisal											◐	◐	◐	◐	◐		●	●	●		FF
Sorghum										◐	◐	◐	●	●	●	●	●	●	●		FF
Soyabeans							●	●	●	●	●	◐	◐			●	●	●	●		FF
Spinach		◐	◐	●	●	◐	◐									●	●	●			FF
Squash						◐	●	●	●	◐	◐					●	●	●	●		FF
Sugarbeat				●	●	●	●	◐	◐							●					FF
Sugarcane										◐	◐	●	●	●	●		●	●	●		FF
Sunflower						◐	◐	◐	●	●	●	●	●			●	●	●	●		FF
Tea							●	◐	◐								●	●	●		FF
Tobacco									●	●	●	●	●	◐	◐	●	●	●	●		FF

LIST OF ADAPTED CROPS IN AGRO ECOLOGICAL REGIONS (AFTER EHLERS)

CROP	TEMPERATURE REGIONS (SUMMER) 25	35	36	46	47	56	57	66	67	77	78	87	88	89	99	FROST FREE AREA				WINTER CODE	RE= MARKS
Tomato				◐	◐	◐	◐	◐	●	●	●	◐	◐			●	●	●	●		FF
Tung-oil									●	●						●	●	●		35	
Turnip				●	●	●	●									●	●	●			FF
Vegetable marrow						◕	◕	◕	◕	◕	◕	◕	◕	◕		●	●	●	●		FF
Walnut					◕	◕	◕	◕	◕	◕	◕	◕				●	●			35	
Watermelon								●	●	●	●	●	●	●	◕	●	●	●	●		FF
Wheat			◔	●	●	●	●	●	◐											25	

A SIMPLE CLIMATIC CLASSIFICATION FOR TROPICAL AND SUBTROPICAL AREAS AND FRUITS IN SOUTH AFRICA

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ABSTRACT

The ecology of tropical and subtropical climates and crops is broadly reviewed, and the effects of latitude and altitude discussed. Certain tropical crops which evolved in the humid tropical lowlands, the tropical savannas and the tropical highlands are successfully grown in sub-optimal climates in South Africa. The arbitrary boundary of the 18°C mean July isotherm delineates tropical from subtropical areas. Distinctions are made between the hot, warm and cool subtropics, and the crops best adapted to them. South Africa is divided into seven Climatic Regions suitable to varying extents for the crops under discussion, and 28 localities are evaluated for their broad ecological characteristics.

INTRODUCTION

Frequent reference is made to the terms "tropical", "subtropical" and "temperate" in relation to the ecology of crops and cropping areas. Seldom is any attempt made to define these terms, and there is much inconsistency and ambiguity in their use by agriculturists, geographers and climatologists.

Horticultural tree crops are mostly vegetatively propagated. A clonal cultivar will therefore have fairly specific climatic requirements, and a limited range of adaptability. Due to their perennial nature, tree crops must also be able to withstand climatic extremes occurring over a period of years, and often decades. These facts dictate very careful selection of climates and sites, even aspect and slope (Hudson, 1971), especially as population pressure rises.

This paper broadly reviews the ecology of tropical and subtropical areas and tree crops. A simple but useful horticultural classification of these crops, and the climatic regions to which they are best adapted in South Africa, is presented. It is stressed, as in an earlier paper dealing with Natal (Wolstenholme, 1975), that only broad generalizations are attempted, and that there are other important determinants of ultimate success. These include prudent site and soil selection, irrigation potential, infrastructure and nearness to markets, economic incentives etc. In general, however, the most efficient use of land is made when the crop is grown in an environment as close as possible to its ecological optimum.

TROPICAL CLIMATES AND CROPS

The tropical zone, nominally between 23½°N and S latitude, but with a greater latitudinal range on the E side of the continents in the S hemisphere, is by no means uniform in its climate or soil types. Four major ecological zones are recognised by the Sanchez and Buol (1975), viz. the evergreen forests (24% of the land area), savannas and grasslands (49%), semi-desert (11%) and desert (16%). In addition, some 23% of the tropics exceeds 900 m altitude, constituting the highland tropics. Soils are not nearly as uniform as commonly believed. These variations make for a wide range of habitats and potential agroecosystems.

Tropical lowland climates and crops

The *humid* tropical lowlands, with their almost constant heat, humidity and day length, and their reliable and often excessive rainfall, give the superficial impression of a plant paradise. They have frequently been cited as a future "breadbasket" for an exploding "third world" population, due to their unsurpassed primary productivity and intense biological activity (Alvim, 1975). It has been pointed out, however, that the superabundance of pests and diseases, and the often sterile soils, make for a fragile ecosystem with forbidding problems for sustained-yield agroecosystems (Fosberg, 1973; Janzen, 1973). The tropical forest has even been described in ecological terms, as a desert covered by trees.

Even in terms of solar radiation, the humid tropics are at a disadvantage to subtropical and temperate zones during the summer months. However, night temperatures seldom drop below 15°C, and frost is unknown.

The *savanna* tropics, with at least one dry season and a lower rainfall, have a higher agricultural potential than the humid lowland tropics. This is due both to the less acute plant protection problem (Janzen, 1973), and to the generally less leached soils (Sanchez & Buol, 1975).

Crops which evolved in the humid lowland tropics include bananas, Brazil nuts, cloves, and to a lesser extent coconuts. Cocoa and Robusta coffee require a short, somewhat drier period during part of the year for satisfactory flowering and fruiting, but are in other respects humid tropical lowland in their adaption. Examples of tropical crops adapted to the much drier lowland tropics are mangoes and cashew nuts, and, near the coast, pineapples. The mango is best adapted to a tropical monsoon climate, with a sharply defined and prolonged dry season.

The tropical highlands

Next to the distribution of land and water, altitude is probably the most important factor causing climatic differences at similar latitudes (Trewartha, 1968). Since the mean temperatures decrease by about 1°C for every 300 m increase in altitude, the higher-lying plateaus and mountainous areas in the tropics have a cooler, highland climate. The distinctive features of such climates are the large *diurnal* temperature range, combined with the typical tropical characteristic of a narrow *monthly* temperature range. Frost is possible at high altitudes. The agricultural potential is high (Janzen, 1973).

Fruit crops which evolved in and became adapted to these low-temperature variants of tropical lowland climates include Arabica coffee, the Guatemalan avocado, cherimoya (*Annona cherimola*) and the common purple granadilla. These crops respond best to uniformly cool temperatures without marked temperature extremes. Tea can be regarded as a medium altitude tropical crop adapted to extremely high rainfall areas.

Effects of latitude and distance from the sea

The further one gets from the equator, the cooler are the mean temperatures for a given altitude, the greater the seasonal variations in daylength, and the more distinctly seasonal is the climate. As a very rough rule of thumb, general frost damage in localities not subject to cold air drainage can be expected above approximately 2 250 m in Kenya, 1 500 m in Rhodesia, 900 m in Natal, and a few hundred metres in the S. Cape.

Latitudinal effects can be significant even within South Africa. For example, Pusella (Tzaneen, 23° 50'S) and Pietermaritzburg (29° 36'S) have a very similar altitude and rainfall total, but the mean annual temperature (MAT) of the former is 19,5°C as compared to Pietermaritzburg's 18,5°C. A comparable locality in Rhodesia would be much hotter; one in the Cape a lot cooler.

Coastal climates have a lower temperature range and lesser extremes, due to the moderating effect of humidity, than more inland areas. A low rainfall makes for a high temperature range and greater extremes, as does a valley climate. These principles are well illustrated by comparing the temperature data of Durban, Nelspruit, Goodhouse and Muden (Fig. 2).

BOUNDARY BETWEEN TROPICAL AND SUBTROPICAL CLIMATES

For classification purposes, arbitrary boundaries have been set to differentiate between tropical and subtropical climates. In the widely used climatic classifications of Köppen (1931) and Trewartha (1968), the boundary is taken as the 18°C isotherm of the coldest month. This temperature corresponds reasonably well with the pole-ward (latiduinal) limit of certain tropical plants, e.g. some palms, which cannot tolerate marked seasonal temperature variations, require continuously high temperatures, and are intolerant of frost.

It is of interest that the 18°C July isotherm crosses the Natal coast at Cape St Lucia (28° 30'S), and thereafter extends northwards in the vicinity of the foothills of the Lebombo mountains. South of this area there is a pronounced subtraction in the number of true tropical species of plants and amphibia in particular (Poynton, 1961, 1964), in spite of the absence of topographical or other barriers to southward migration.

The potential evapotranspiration (PE) concept of Thornthwaite (1948), used by RJ Poynton (1971) for his silvicultural map of southern Africa, gives a similar tropical/subtropical "boundary". Poynton, however, subdivided the thermal efficiency index in the mesothermal ("subtropical") zone on the basis of mean July minimum temperatures rather than PE, since the incidence and severity of frost is a major determinant of plant distribution.

On the above basis, the only tropical areas in South Africa are the lowlying Tongaland plain north of Lake St Lucia, and parts of the esatern Kruger National Park and the lower Limpopo valley. These areas have a bushveld (savanna) type vegetation, and are sub-arid.

SUBTROPICAL CLIMATES AND CROPS

Subtropical climates, in addition to having a nominal latitude greater than 23½°, have a mean July temperature below 18°C. The lower temperature boundary of the subtropical zone can be taken as approximately the 13°C July isotherm, although local topography can result in lower values in what are from the heat unit aspect essentially subtropical areas, e.g. the deep river valley situation of Muden (Fig. 2). Poynton (1961) found that this isotherm corresponds well with the boundary of the transitional faunas between tropical and temperate types. He delineated the subtropical zone as lying between the 13°C and 18°C July isotherms in his map of the biotic divisions of Southern Africa.

From a horticultural point of view, the incidence and severity of frosts are of cardinal importance. Subtropical tree crops, evolving in environments where at least some measure of frost resistance was essential for survival, tolerate light frosts as long as they are not actively growing or flowering. Generally speaking, absolute minima should not be lower than −3 or −4°C, and sometimes even less.

The subtropics, being further from the equator, have greater diurnal and seasonal temperature extremes than the tropics, although this can be modified by rainfall, humidity, topography, aspect and altitude. Daylength is longer in summer and shorter in winter than in the tropics. Subtropical fruit trees are more tolerant of high summer temperatures and of seasonal extremes. For some months of the year, temperature and/or drought limitations exist for plant growth, and also have tha beneficial effect of reducing pest, disease and weed populations.

Typical subtropical fruit trees are most of the citrus fruits, the date, loquat, fig, pomegranate, litchi, Mexican avocado, *Macadamia tetraphylla*, guava, and Chinese gooseberry. The West Indian avocado and *M. integrifolia* have more tropical than subtropical features.

A HORTICULTURAL CLASSIFICATION FOR SOUTH AFRICA

The above principles are used as the basis for a simple climatic classification of tropical and subtropical areas, and of warmth-loving perenial horticultural crops, for South African conditions.

To be meaningful, further subdivision of the subtropical zone is desirable. The well-known heat unit concept is helpful in this respect, and annual heat unit totals above a base temperature of 10C have been calculated for 28 representative localities (Fig. 2). Thornthwaite's "mesothermal" subdivisions, especially B4 and B3 of his thermal efficiency index, do not take into account the extreme importance of the frost factor for perennial evergreen crops.

The approach adopted by the German plant ecologist Walter (1971) is regarded as having much merit. His climate diagrams incorporate ecologically significant climatic parameters, clearly portraying seasonal variations in climate. Although his empirical plotting of mean monthly temperatures and precipitation, using a scale of 10°C = 20 mm rainfall, could be criticized, it appears to be a better biological basis for estimating the water balance than that of Thornthwaite (1948).

Slightly modified climate diagrams for 28 localities are given in Fig. 2. Details of the notation used appear in Fig. 1. A study of these and of available climate statistics. (Anon., 1955, 1974; Schulze, 1965) suggests seven reasonably homogeneous *Climatic Regions* suitable for commercial growing of the crops in question (Table 3):-

I. **Tropical Lowland Savanna.** This Region has a mean monthly July temperature exceeding 18°C, an annual heat index in excess of 4 500, and is frost-free. Only a very small portion of N.E. coastal Natal and the lowest-lying N.E. Transvaal fulfil these criteria, and even then the climate is only marginally tropical, or semi-tropical.

II. **Hot Subtropical Region.** The mean July temperature is slightly below 18°C and the annual heat index between 4 000 and 5 000. Although usually frost-free, very light and infrequent radiation frosts are possible in river valleys. Except for a small portion of coastal N. Natal, e.g. S of Cape St Lucia, this is ecologically a subhumid (Pongola) to mild subarid (Komatipoort, Kaapmuiden, Ofcolacvo) portion of South Africa.

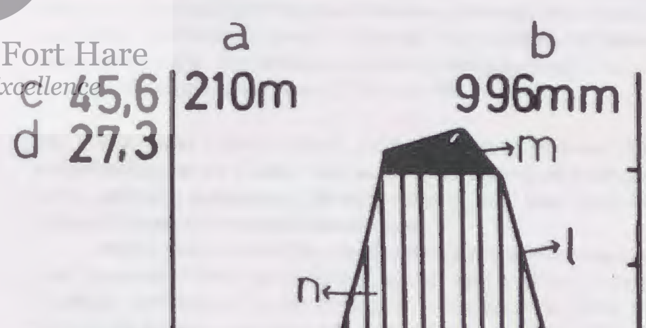

FIG. 1: Typical climate diagram with explanation

FIG. 1: Tiplese klimaatsdiagram met beligting

a = altitude (m); b = mean rainfall (mm); c = abs. max. temp. °C; d = mean daily max. hottest month; e = mean daily temp. range; f = mean daily min. coldest month; g = abs. min. temp.; h = mean monthly temp. curve (one scale interval = 10C); i = 18°C line (index of tropicality); j = annual heat units above 10°C; k = mean annual temp.; 1 = mean monthly rainfall curve (scale 10C = 20 mm); m = mean monthly rainfall > 100 mm (scale reduced to $^1/_{10}$); n = humid period; o = drought period; p = months, from July to June. (After Walter, 1971)

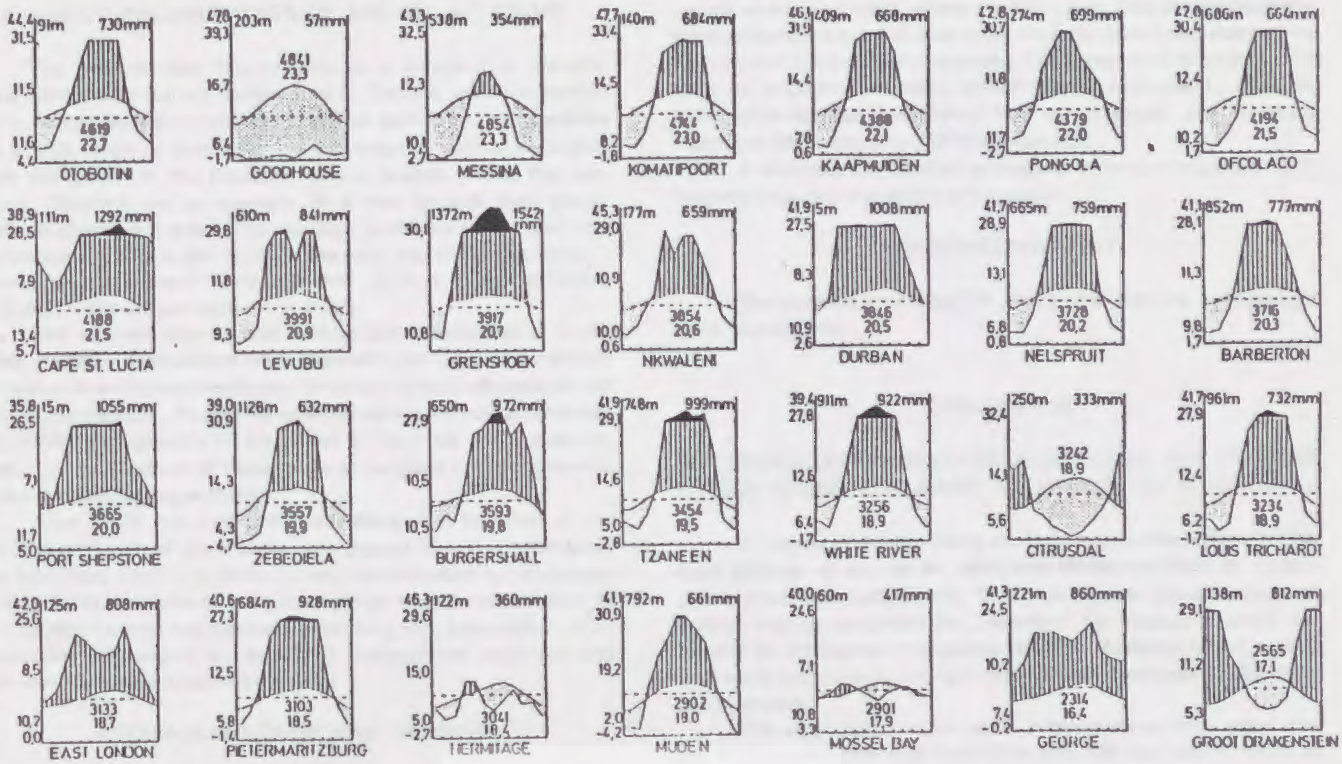

FIG. 2: Climate diagrams for 28 weather stations (After Walter, 1971)
FIG. 2: Klimaatsdiagramme vir 28 weerstasies (Aangepas van Walter, 1971)

III. Warm Subtropical Region. Slightly cooler on average than the Hot Subtropics, the annual heat index varies from 3 500 to 4 000. Occasional light frosts may occur in inland non-escarpment areas. Typical localities are Nelspruit, Burgershall, and Grenshoek (near Tzaneen) below the escarpment. Interior to the escarpment these are colder, e.g. Zebediela. The Natal coastal strip south of Mtunzini to beyond Port Shepstone is a humid frost-free but Warm Subtropical area.

IV. Cool Subtropical Region. The annual heat index varies from 2 500 to 3 500. Coastal localities such as East London are frost-free, but interior localities such as Hermitage (Addo), Pietermaritzburg, White River, Louis Trichardt and especially Rustenburg may experience light to moderate frosts.

V. Southern Cape Coastal Region. From about Humansdorp to Mossel Bay, the coastal strip south of the main coastal mountain ranges experiences a mild climate with all-year rainfall. The heat index is between 2 000 and 3 000, and light frosts occur at higher levels. Knysna and George are typical forestry towns in this Region.

VI. The Mediterranean S.W. Cape, with winter rainfall, is not an important potential evergreen fruit tree area, although some localities, e.g. Groot Drakenstein have sufficiently mild winters for selected crops. In the north, Citrusdal is a significant citrus area with a very hot summer. Heat indices vary from 2 000 to 3 500.

VII. The West Coast Desert, below an altitude of about 400 m and extending up the Orange river valley to the vicinity of Aughrabies, has a basically subtropical climate, varying from cool and foggy (coastal) to very hot and arid (Goodhouse).

Within these seven Climatic Regions, large differences exist in both the amount and distribution of rainfall, and in Walter's concept of debits and credits in the ecological water balance. Both these factors can be important determinants of horticultural crop potential, even if irrigation facilities exist.

To further delineate the Climatic Regions, two other parameters are suggested. Firstly, the seven *Rainfall Groups* A–G are based on total annual rainfall, with the suffix a) indicating a summer rainfall area, b) a winter rainfall area and c) all year round rainfall. Secondly, seven *Aridity Factors* (1–7) give an indication of the number of water deficit ("drought") months of the year, based on the climate diagrams (Fig. 2, Table 1).

TABLE 1: Criteria for classification of rainfall groups and aridity factors within Climatic Regions
TABEL 1: Maatstawwe van klassifikasie vir reënval intervalle en vogtigheidsfaktore binne klimaatsgebiede

Rainfall group/ *Reënvalinterval*				Aridity factor/ *Vogtigheidsfaktor*		
A		>	1 200 mm	1	Very humid	(0–1 drought months)
B	1 000	–	1 200 mm	2	Humid	(2–3 drought months)
C	800	–	1 000 mm	3	Sub humid	(4–5 drought months)
D	600	–	800 mm	4	Mild subarid	(6–7 drought months)
E	400	–	600 mm	5	Subarid	(8–9 drought months)
F	200	–	400 mm	6	Arid	(10–11 drought months)
G	*	–	200 mm	7	Very arid	(12 drought months)

*According to Walter's (1971) criteria (see Figs. 1 & 2)
**Volgens Walter (1971) se kriteria (sien Fig. 1 & 2)*

CLIMATIC REQUIREMENTS OF THE MAJOR CROPS

The main climatic requirements of a selection of warmth-loving perennial crops are summarized in Table 2, with the nearest South African equivalent climates listed for each crop. It is apparent that a wide range of essentially tropical crops of diverse ecological origin are grown in the Republic, almost entirely within the sub-tropics. Bananas are an example of a true tropical crop grown locally in subtropical areas. The resultant problems of variable crop distribution and fruit quality through the year, and of "choke-throat", "November bunch" and "plantation chill" (Kuhne, Kruger & Green, 1973) are predictable consequences of this.

The relatively new tea and Arabica coffee industries of South Africa are other examples of how economic and political incentives can over-rule ecological desiderata. Tropical highland climates do not occur in the Republic, the nearest approach being the cool subtropical, high rainfall escarpments of the N and E Transvaal and subcoastal Natal. The local culture of these crops in marginal habitats presents unique and challenging problems.

Allan (1976) has shown that advantage can be taken of the slower growth rate of the tropical crop papaya in a cool subtropical (but frost-free) locality to produce very remunerative out-of-season fruiting. Other examples of the successful commercial exploitation of ecologically marginal environments could be given. Economic success is however, dependent on advanced management expertise and experience based on extensive research.

RECONCILING CROP AND CLIMATE

A knowledge of the broad climatic and soil requirements of a crop, and of the essential ecological parameters of a particular locality is of use as a first step in land-use planning. Tables 1, 2 and 3 present summarized information on these topics. Generalized extrapolations can be made from such data, but it must be stressed that the final arbiter is subsequent prudent site evaluation and selection within the broadly suitable area. In the final analysis, factors such as soil series, aspect, topography and exposure to wind will become increasingly important.

CONCLUSIONS

The limitations of the broad approach adopted in this paper are fully realized. It is nevertheless believed that the principles outlined are often not understood or appreciated at the extension level, so that unwise or even incorrect advice may be given. The simple classifications presented are a first step in ecologically sound-decision making for perennial horticultural enterprises. The importance of other factors such as irrigation potential, infrastructure, nearness to markets, sociological aspects, established land use practices, and economic incentives (Wolstenholme, 1976) is axiomatic.

A discussion of detailed ecology of individual crops and even cultivars is beyond the scope of this paper.

ACKNOWLEDGEMENT

The assistance of Miss DN Goddard in drawing the figures is much appreciated.

OPSOMMING

'N EENVOUDIGE KLIMAATSKLASSIFIKASIE VIR TROPIESE EN SUBTROPIESE GEBIEDE EN VRUGTE IN SUID-AFRIKA

Die ekologie en uitwerking van breedtegraad en hoogte bo seespieël bespreek vir tropiese en subtropiese klimaatstoestande en tuinbougewasse wat daar verbou word. Sommige tropiese gewasse wat in die vogtige tropiese laaglande (bv. piesangs), die tropiese savanne (bv. papaja) en die tropiese hooglande (bv. tee, Arabiese koffie) ontvou het, word suksesvol in sub-optimum klimaatstoestande in die Republiek gekweek.

Die grens tussen tropiese en subtropiese gebiede word deur die 18°C gemiddelde Julie isoterm bepaal. Die baie warm, warm en koel subtrope, en die gewasse wat in elk die mees aanpasbaar is, word afgebaken. Suid-Afrika is in sewe Klimaatstreke wat vir hierdie gewasse geskik is ingedeel, en 28 gebiede is vir hulle algemene ekologiese eienskappe van belang vir tuinbou geëvalueer.

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TABLE 2: Summarized optimum climatic requirements for selected crops
TABEL 2: Opgesomde optimum klimaatsvereistes vir geselekteerde gewasse

Crop/Gewas	Optimum climate/*Optimum klimaat*	*R.S.A. equivalent *R.S.A. ekwivalent*
Coconut	Tropical equatorial lowland, maritime, high rainfall, humid	I, A–Bc, 1
Cashew nut	Tropical savanna lowland, medium rainfall, subhumid to semi-arid	I, C–Da, 2–5
Banana	Tropical lowland, high rainfall, humid	I, A–Bc, 1
Mango	Tropical monsoonal lowland/hot subtropical, low rainfall, arid	I–II, D–Fa, 4–6
Papaya	Tropical savanna lowland/hot subtropical, med. rainfall, semi-arid	I–II, C–Ec, 3–4
Pineapple	Tropical to semi-tropical lowland, maritime, med. rainfall, humid	I–II, C–Dc, 2–3
Grapefruit	Tropical savanna lowland/hot subtropical, med. rainfall, humid/subhumid	I–II, C–Da, 2–3
Pecan nut	Continental (hot summer/cold winter), low to med. rainfall, subhumid to arid	* C–Ea, 2–6
Valencia orange	Hot to warm subtropical, med. rainfall, subhumid	II–III, C–Da, 2–4
Litchi	Warm to hot subtropical, high rainfall, humid	III–II, A–Ba, 2–3
Macadamia	Warm to hot subtropical, med. to high rainfall, subhumid	III–II, A–Ca, 2–3
Navel orange	Warm to cool subtropical, med. rainfall, subhumid to semi-arid	III–IV, C–Da, 2–5
Tea	Highland tropical, very high rainfall, very humid	III–IV. Ac, 1
Arabica coffee	Highland tropical, high rainfall, subhumid	III, A–Ba, 2
Avocado (Guat.)	Highland tropical/cool subtropical, high rainfall, humid	IV–V, A–Ca, 2
Granadilla (purple)	Highland tropical/cool subtropical, med. rainfall, subhumid	IV–VI, B–C, 2–3
Chinese gooseberrey	Cool subtropical/warm temperate, high rainfall, humid	IV–VI, A–B, 1–3
Date	Hot desert subtropical, very low rainfall, arid	VII, G, 6–7

*I–VII = Climatic Region/*Klimaatstreek*
A–G = Rainfall Group/*Reënvalinterval*
1–7 = Aridity factor/*Vogtigheidsfaktor*

TABLE 3: Summarized climates for 28 localities
TABEL 3: Opgesomde klimaat van 28 weerstasies

Climatic Region *Klimaatstreek*	Weather station *Weerstasie*
Tropical savanna/*Tropiese savanne*	Otobotini (I, D, 4); Messina (I—II, E, 6); Cape St Lucia (I—II, A, 1)
Hot subtropical/*Baie warm subtropies*	Komatipoort (II, D, 4); Kaapmuiden (II, D, 4); Pongola (II, C, 4); Ofcolaco (II, D, 4)
Warm subtropical/*Warm subtropies*	Levubu (III, C, 3); Grenshoek (Tzaneen) (III, C, 1); Nkwaleni (III, C, 4); Durban (III, A, 2); Nelspruit (III, C, 4); Barberton (III, C, 4); Port Shepstone (III, A, 2); Zebediela (III, D, 4); Burgershall (III, C, 3)
Cool subtropical/*Koel subtropies*	Pusella (Tzaneen) (IV, C, 3); White River (IV, C, 3); Louis Trichardt (IV, C, 4); East London (IV, A, 3); Pietermaritzburg (IV, C, 3); Hermitage (Addo) (IV, F, 6); Muden (IV, C, 4)
S. Cape coastal/*S. Kaap kusstreek*	Mossel Bay (V, D, 5); George (V, A, 3)
Warm mediterranean/*Warm winterreenvalstreek*	Groot Drakenstein (VI, C, 3)
Hot desert subtropical/*Baie warm woestyn subtropies*	Goodhouse (VII, G, 7)

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THE CHOICE OF CROPS

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The choice of crops to be planted in an area is determined by three factors, namely climate, soil and water availability

Climate: It is determined by the prevailing temperature, relative humidity, rainfall, wind, altitude and slope.

Soil: The requirements of the different crops vary with regard to soil type, drainage depth and pH.

Water: Irrigation water must be available. The quantity and application differ from crop to crop.

CLIMATIC AREAS

Different climatic areas can be identified according to climatic data, namely:

AREA A	Hot, humid, frost free
AREA B	Hot, arid, frost free
AREA C	Warm summer and cool winters with the possibility of frost
AREA D	Cool summers, humid, frost free

The different subtropical crops can be classified accordingly, e.g.:

AREA A	Banana, Macadamia, Coffee, Tea, Ginger
AREA B	Mango, Papaya
AREA C	Macadamia, Guava, Pecan (where frost occurs), Kiwi (where frost occurs)
AREA D	Avocado, Granadilla, Macadamia

It is however, better to determine limiting values for each crop and to compare the climatic data of an area to decide if a crop will grow successfully.

LIMITING TEMPERATURES

For the different crops the following limiting values are critical:

Avocado and Macadamia nut
The average monthly maximum summer temperature should not be higher than 29°C.
The average monthly minimum winter temperature should not be lower than 3°C.

Banana
the average monthly minimum temperature must be above 7,5°C during winter and above 18°C during summer.
The relative humidity must be above 50% at 14h00 during summer.

Coffee
The average monthly maximum summer temperature must not be higher than 28°C.
The average monthly minimum winter temperature must not be lower than 9°C.

Ginger
At temperatures above 32°C sunburn occurs. Overhead sprinkler irrigation must be installed to prevent sunburn.

Granadilla
The average monthly maximum summer temperature should not be higher than 29°C.
The average minimum winter temperature should not be lower than 6°C.

Guava
The average monthly maximum summer temperature should not be higher than 32°C.
The average monthly minimum winter temperature should not be lower than 3°C.

Kiwi fruit
The average monthly maximum summer temperature should not be higher than 28°C.
The average minimum temperature during winter must be below 8°C for approx 400 hours.
The period 15 September to 15 May must be frost free. Frost may occur from 15 May to 15 September.

Litchi
The average monthly maximum temperature should be lower than 32°C but higher than 26°C during the last month of fruit development.
The average monthly minimum temperature should be above 6°C but under 14°C for three or four winter months.
The relative humidity should be above 50% at 14h00 from October to fruit ripening.

Mango and Papaya
The average monthly maximum summer temperature should not be higher than 36°C.
The average monthly minimum temperature should not be lower than 5°C.
The relative humidity should be under 55% from October to fruit ripening.

The maximum permissible rainfall is:

September	50 mm
October	85 mm
November	110 mm
December	150 mm
January	150 mm
February	150 mm

Pecan
The average monthly maximum temperature should be above 28°C during summer and lower than 23°C during winter.
The average monthly minimum temperature should be above 15°C during summer, but lower than 8°C during winter.
Sever frost may occur during winter, but the period 15 September to 15 May must be frost free.

Tea
The average monthly maximum summer temperature must be lower than 27°C
The average monthly minimum winter temperature must be above 3°C.
The average annual rainfall must be above 800 mm.

Crop selection sheet

	Beans Peas	Crucifers	Avocado	Citrus Mango Macadamia	Gapes	Lychee	Custard apple, Papaw, Passionfruit	Pineapples	Peaches Kiwifruit	Pecan nuts	Cucurbits
Aspect											
N-NE-E	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SE	Marg	Yes	Marg	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
W-SW-S	No	Yes	No	Marg	Marg	Marg	No	Marg	No	Yes	Marg
Frost											
Nil	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Light	Marg	Yes	Marg	Marg	Yes	No	No	No	Yes	Yes	Marg
Heavy	No	Yes	No	No	Yes	No	No	No	No	Yes	No
Irrigation per ha											
7.5 ML plus	Yes	Yes	Yes	Yes	Yes	Yes	Yes	rarely	Yes	Yes	Yes
3-7.5 ML	Yes	Yes	Marg	Marg	Yes	Marg	Marg	used	Marg	Marg	Yes
1-3 ML	Yes	Marg	Marg	No	Yes	No	No		Marg	No	Marg
1 ML	No	No	No	No	No	No	No		No	No	No
Soil depth											
Greater than 3 m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1-2 m	Yes	Yes	Marg	Yes	Yes	Yes	Yes	Yes	Marg	Marg	Yes
30 cm-1 m	Yes	Yes	No	No	No	No	Marg	Yes	No	No	Yes
30 cm	No	No	No	No	No	No	No	Marg	No	No	Marg
Drainage											
Free	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fair	Yes	Yes	Marg	Marg	Marg	Marg	Marg	Marg	Marg	Marg	Marg
Poor	No	No	No	No	No	No	No	No	No	No	No
Wind											
Protected	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Partially protected	Marg	Marg	Marg	Marg	Yes	No	No	Yes	No	Marg	Marg
Exposed	No	No	No	No	Marg	No	No	Yes	No	No	No

Crop selection sheet

	Lettuce, Celery	Strawberries	Onion, Potatoes	Tomato, Capsicum, Eggfruit	Carrots, Beetroot	Sweet potato	Ginger	Sweet corn	Guava	Persimmon	Apples, Pears
Aspect											
N-NE-E	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
SE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
W-SW-S	Yes	Marg	Yes	Marg	Yes	Yes	No	Yes	Yes	No	Yes
Frost											
Nil	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Light	Yes	Marg	Marg	Marg	Yes	Marg	Marg	No	Yes	Yes	Yes
Heavy	Marg	No	No	No	Marg	No	No	No	No	Yes	Yes
Irrigation per ha											
7.5 ML plus	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3-7.5 ML	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1-3 ML	Marg	Marg	Marg	Marg	Yes	Yes	Marg	Marg	Yes	No	No
1 ML	No	No	No	No	Marg	Yes	No	No	No	No	No
Soil depth											
Greater than 3 m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1-2 m	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
30 cm-1 m	Yes	Yes	Yes	Yes	Marg	Marg	Yes	Yes	Marg	No	No
30 cm	Yes	Marg	Marg	Marg	No	No	Marg	Yes	No	No	No
Drainage											
Free	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fair	Marg	Yes	Marg	Marg	Marg	Yes	Marg	Yes	Yes	Marg	Marg
Poor	No	No	No	No	No	No	No	No	No	No	No
Wind											
Protected	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Partially protected	Marg	Yes	Yes	Marg	Yes	Yes	Marg	Yes	Yes	No	Yes
Exposed	No	Marg	Marg	No	Marg	Yes	No	No	Marg	No	No

VEGETABLE SERIES No. E.2/1974
Farming in South Africa

THE CULTIVATION OF VEGETABLES IN SOUTH AFRICA

I. GENERAL INFORMATION CONCERNING THE CULTIVATION OF VEGETABLES IN SOUTH AFRICA

E.2. A GUIDE TO FERTILISING VEGETABLE CROPS

by

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It must be emphasized that due to variations in soil fertility, accurate fertiliser recommendations cannot be made without soil analyses. The figures given below are intended as a guide and must be used accordingly.

Note that all recommendations are in kilograms per hectare, 1 kg/ha is approximately equal to 2 lb per morgen and 500 kg/ha (50 g/m^2) to 1½ oz per square yard.

No recommendation is made for the application of compost or kraal manure because they are not always available. Where they are available however, amounts up to 30 cubic metres per hectare can be used with advantage on most crops, but not on carrots, beetroot or beans.

Recommendations are made in three parts:

(1) A basal application which should be spread evenly over the area and worked in one to two weeks before the crop is planted on the land.

(2) A pre-planting application which should be spread in the rows immediately before planting.

(3) Topdressing to be applied when the plants are well established;

   (a) where only one topdressing is given usually after three to five weeks, and

   (b) Where two topdressings are necessary approximately in the fourth and eighth week after planting.

Nitrogen fertiliser recommendations have been made in terms of nitrogen, because the different fertilisers do not contain the same amounts of nitrogen: eg. 100 kg nitrogen is contained in 475 kg ammonium sulphate, in 330 kg of 30% limestone ammonium nitrate, or in 215 kg urea. With acid soils, limestone ammonium nitrate is usually the best nitrogenous fertiliser to use, but with soils that are only slightly acid to alkaline, ammonium sulphate or urea are preferred.

Lime should be applied as indicated by soil analysis and worked in at least four weeks before the crop is planted.

CONCLUSIONS

1. Scenery Park is an urban development project being implemented in phases. The envisaged project includes the development of urban agriculture on that portion of Scenery Park situated in the Buffalo River valley. This area used to be farmed as a commercial unit. There is now very limited farming activity and the old lands have been encroached by bush.

2. The area on the higher-lying ground to the east has been developed as a low-cost housing project with basic infrastructure.

3. On much of the western bank and slopes of the Buffalo River is the Fort Grey Forest Reserve with its pristine coastal forest vegetation. There is also this and other indigenous vegetation on Scenery Park. Scenery Park is therefore part of a greater and sensitive ecological unit and any proposed development on Scenery Park should take this into account. Presumably a study of the ecological impact of such development will have been undertaken.

4. Approximately half of the area that we were asked to assess with respect to its potential for crop production, and which was mainly land previously cultivated, was found to be unsuitable for cultivation. Much of the remainder of this land in considered to be marginal because of rooting depth and/or drainage limitations. Therefore only 13,2% of the area, just under 10 hectares of land, is considered to have a moderate or moderate to good potential for irrigated cropping. The potential for rainfed cropping is similar. No land has a very high potential for either of the two systems of cropping.

5. Two options are available. The first option would be to leave the land, that we consider suitable for cropping, uncultivated. The second option would be to implement the urban agricultural project, as intended by the developers.

   Two types of land use suit conditions reasonably well, namely vegetable production and dairy farming. The establishment of a dairy unit would require some or all of the land to be used for the production of kikuyu, lucerne and maize. Suitable combinations of these three crops can ensure the availability of sufficient feed throughout the season and produce a nutritionally balanced ration except in terms of phosphorus, which can be supplied in the form of a lick. Silage production is expensive in terms of capital outlay and it would therefore be recommended that only stover is fed to the dairy herd. Stover could be cut by hand after removing the cobs, which could be sold as "green mealies" in the township. Kikuyu would be used as a pasture and the lucerne as hay.

   Vegetables could be grown as part of a commercial venture or as small units or community gardens as part of an urban agricultural project. The vegetable production could make use of the manure produced by the dairy animals.

The raising of poultry(and rabbits) would be another possibility.

Owing to the sensitive agro-ecological situation of Scenery Park, we would not be in favour of the use of the land for communal grazing of cattle, sheep and goats, because of the apparent difficulty to control or manage such a system in terms of sound, sustainable agricultural and conservation principles and practices. The impact of dairy farming on the vegetation is less severe.

The thornbush that has encroached could initially be used as a source of fire wood, rather than be browsed, and this for the above stated reasons.

We do not recommend the commercial production of fruit but we would encourage the growing of a range of fruit trees in home gardens if these are to be established.

6. Unemployment is likely to remain an important issue in the years to come in spite of the nearness of Scenery Park to the industrial and commercial sectors of East London. A dairy unit (possibly also poultry and /or rabbits), but especially vegetable production largely based on manual labour, could provide some relief for the unemployment problem.

7. It is beyond the scope of this study to recommend ways in which urban agriculture could be implemented at Scenery Park. We have confined our study to an investigation of the potential for cropping based on the climate, soils and water. We hope to have also created an awareness of some of the other factors to consider in crop production.

8. The adoption of an agricultural enterprise, be it a dairy or vegetable and crop production, or a combination of enterprises, would have to be based on more detailed investigations of production practices, yields, economics, implementation, management etc.

9. A R D R I could be approached with regard to more detailed investigations.

10. Socio-economic factors and considerations would be of paramount importance in considering and implementing an urban agricultural development project.

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