CHAPTER NINE: SOIL SUITABILITY ASSESSMENT

9.1. INTRODUCTION

This Chapter of the report presents the findings of the Reconnaissance Soil Survey conducted by the soil specialist Coenraad Fraenkel (Pr.Sci.Nat 400714/15) of Agrimotion Consulting. The study was commissioned as part of the Environmental Impact Assessment (EIA) process in order to determine the suitability of the soils on the site for the commercial production of citrus; and to refine the project layout by identifying areas most suitable for cultivation.

9.2. SPECIALIST TERMS OF REFERENCE

The terms of reference (ToR) for a reconnaissance soil survey as requested by the applicant are stated below. The ToR for soil assessment for the application for clearing of natural vegetation for agricultural purposes are:

- A reconnaissance soil survey of the uncultivated land in order to establish the soil distribution and limitations in terms of the soil's physical and morphology properties.
- Compilation of a soil map on a suitable scale to describe the natural distribution of the soils.
- Description of the different soil types in terms of their physical and morphological properties.
- To identify the more important soil physical and/or morphological limitations of the soil types.
- Evaluation of the relative suitability of the different soil types for cultivation of irrigated citrus.
- No chemical soil analysis is required at present.

9.3. APPROACH AND METHODOLOGY

Predetermined locations for profile pits were set out in a grid lay-out but due to very dense vegetation not all the locations could be reached by the excavator. The profile pit method is preferred to the soil auger method as the layering and structure can be observed in an undisturbed profile.

A site survey was undertaken in January 2017. See map 9.1 below for the location of the site. Eighteen (18) profile pits were classified according to the South African soil classification system (Soil Classification Working Group, 1991) into soil forms and soil families. Observations that are made at each profile pit include detail regarding: texture, colour, mottling, structure, coarse fragments, hardpans, horizon depths, etc. These properties are noted because two different soil pits may have the same (or similar) diagnostic horizons present but may vary in terms of the properties listed above.

Map 9.1: Google Earth Map indicating the location of the site.

Classification of soils entails the identification of the sequence of diagnostic horizons. Diagnostic horizons are horizontal layers which can be observed in the soil and which have developed pedogenically over a period of time. There are 30 different diagnostic horizons in the South African classification system. Horizons develop under varying conditions within the soil. Thus, knowing the name of a horizon allows one to deduce information about the soil structure, chemical status, wetness conditions, degree of weathering and weathering forces present. A soil form consists of a unique sequence of soil horizons.

Maps were drawn based on the field survey. These various maps indicate profile positions, soil distributions, soil map units and soil potential. The soil properties, limitations and recommended soil management practices are discussed. The land is classified under 5 different suitability classes and are presented as a hectare value and as a percentage of the total area.

9.4. SOIL FORM AND POTENTIAL

9.4.1. Soil Forms Classified

Etosha (Et):

Orthic A horizon (ot):

The orthic A horizon is a topsoil horizon which does not classify as an organic O, humic, vertic or melanic A horizon. It is the most widespread topsoil in South Africa and it exhibits an extensive range of characteristics, which in most instances mimics that of the subsoil. There is nothing specifically limiting or characteristic of this horizon.

Neocutanic B horizon (ne):

A Neocutanic B horizon has cutans as a result of illuviation (movement) of clay particles into the horizon. There is more aggregation of the soil particles (structure) than that found in an apedal horizon, but not enough structure to classify it as a pedocutanic B or prismacutanic B horizon. This horizon is suitable for root development and generally has a good water and nutrient holding capacity.

Sepane (Se):

Orthic A horizon (ot):

As described above.

Pedocutanic B horizon (vp):

A pedocutanic horizon is a blocky structured B horizon with cutanic character. Cutanic character refers to a morphological feature where mobile clay and other soil material forms films or skins (cutans) around larger soil aggregates. The presence of cutans are in many instances implicit of a more dispersive clay phase. The transition between the pedocutanic subsoil and the overlying horizon is gradual and sometimes difficult to observe. In addition, the moderate to strongly developed block structure represents a restriction to root growth although variations in the degree of structural development is often present. Fine blocky structure is more suitable for root development and crop cultivation than a coarser block structure.

Unconsolidated material with signs of wetness:

Unconsolidated material represents loose soil materials that usually occur in footslope or level depositional positions. Its presence is used to indicate whether a profile developed in situ or on transported material. This horizon distinguishes subsoil material that have suffered the effects (e.g. iron reduction) of intermittent or prolonged water saturation.

Oakleaf (Oa):

Orthic A horizon (ot):

As described above.

Neocutanic B horizon (ne):

As described above.

Unspecified material:

Unspecified soil material is not a defined horizon but it encapsulates different soil types which occur at depth and exhibit a wide variety of characteristics.

Dundee (Du):

Orthic A horizon (ot):

As described above

Stratified alluvium (al & U1-7):

Stratified alluvium is an unconsolidated horizon consisting of layers which form as a result of different alluvial (river) depositional processes. The layers can differ in their composition, most noticeably in terms of their textures and coarse fragment contents. The pedogenetic changes in these horizons are minimal and they represent youthful soils.

Coega (Cg):

Orthic A horizon (ot):

As described above

Hardpan carbonate horizon (hk):

The hardpan carbonate horizon is characterised by a build-up of free carbonates to the extent that the carbonates have cemented the horizon. The hardened nature of these horizons in effect pose a restriction to root growth and water infiltration. Hardpan carbonate horizons usually developed in drier areas where carbonates can accumulate without being leached out of the soil through frequent rainfall events.

Gamoep (Gm):

Orthic A horizon (ot):

As described above

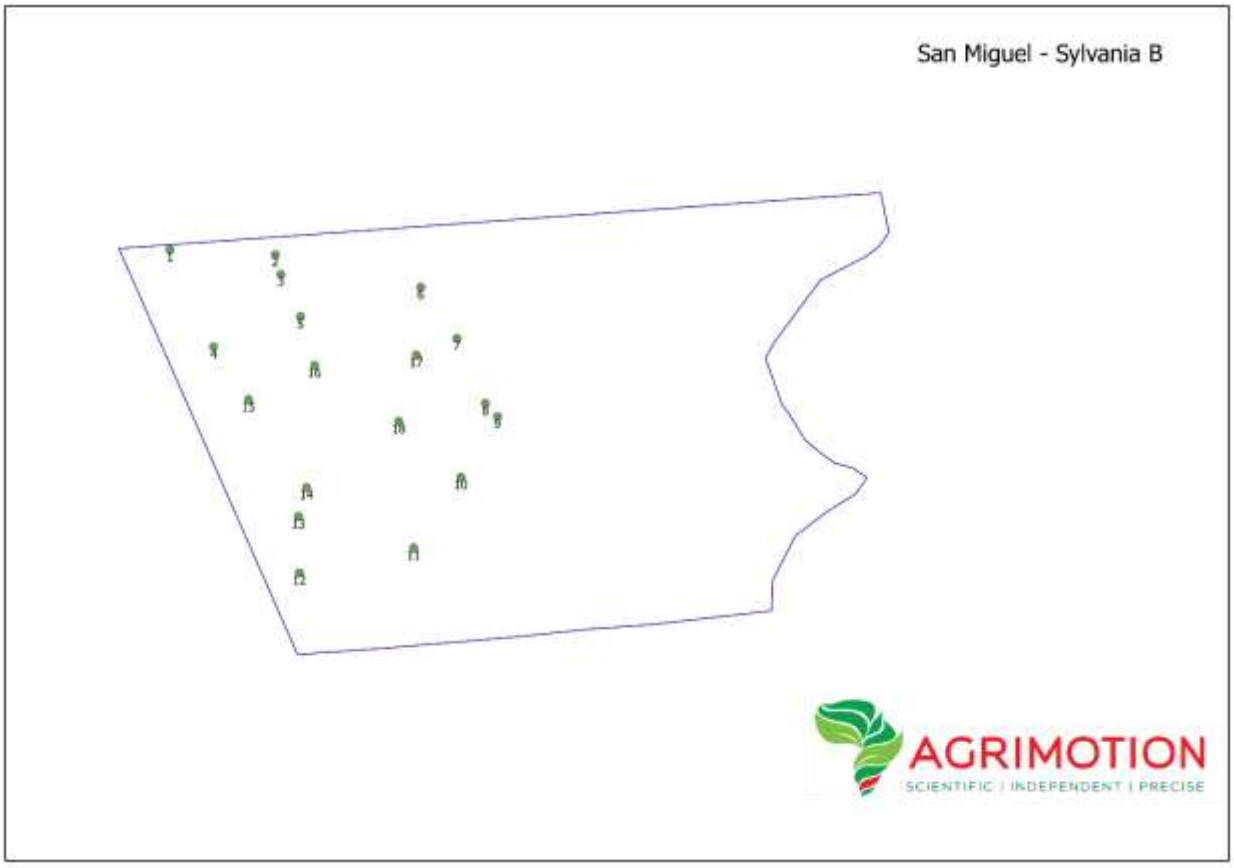
Neocutanic B horizon (ne):

As described above

Hardpan carbonate horizon (hk):

As described above

The profile pit positions are shown in Map 9.2 below.



Map 9.2: Profile pit locations.

The soils described above were divided into soil types according to the properties that were noted in the field. A soil map was drawn based on the above and is indicated map 9.3 below.

The most limiting factors for each soil map unit are described in Table 9.1, along with the approximate area occupied by this soil map unit and the percentage area of the total.

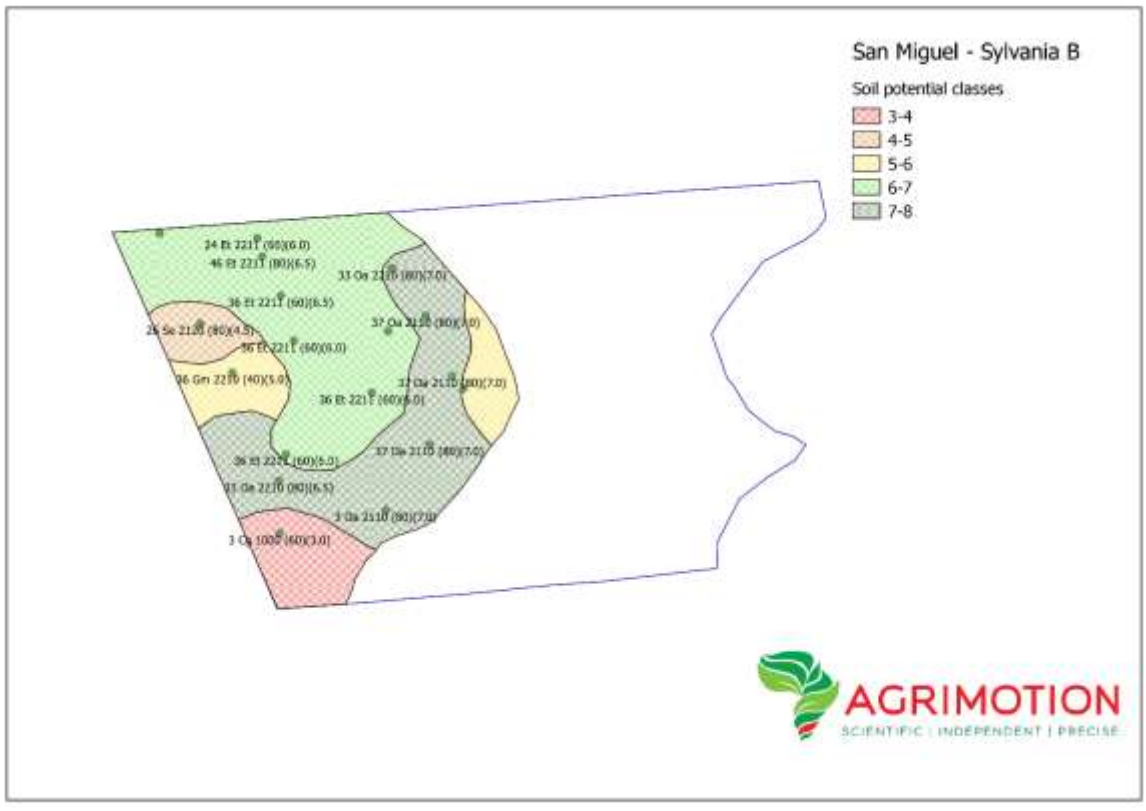
Table 9.1. Grouping of soils into soil map units as shown on the soils map.

Soil type	Limitations	Area (ha)	Proportional area (%)
Sepane	Heavy clay layer from 30cm	5.41	4.84%
Oakleaf	None	35.67	31.92%
Coega	Carbonate rich conditions from a depth of 30 cm	10.07	9.02 %
Dundee	Varying layers of sand, clay from a depth of 60cm.	5.73	5.12 %
Etosha	Free lime from a depth of 60cm	47.65	42.65 %
Gamoep	Carbonate hard setting from a depth of 60cm.	7.21	6.45 %
	Total	**111.74 ha**	**100%**

9.4.2. Soil Potential

A soil potential is awarded to each classified soil profile according to the observations made in the field. The soil potential ranges between 1 (very poor) to 10 (exceptional) and it serves as an indication of the soil's capacity to sustain fruit production in its current state. Various cultivation practices can be applied to the soil (e.g. soil preparation, ridging, drainage) to improve the soil's capacity to sustain fruit production. Different soils are more or less suitable for different crop or cultivar types, depending on the plant's natural capacity to cope with different soil conditions.

The soil potential distribution is indicated in Map 9.3 below. Each suitability class is briefly described in Table 9.2 and the areas occupied by each class is summarized in Table 9.3.



Map 9.3: Soil Map indicating profile pits, soil types and potential.

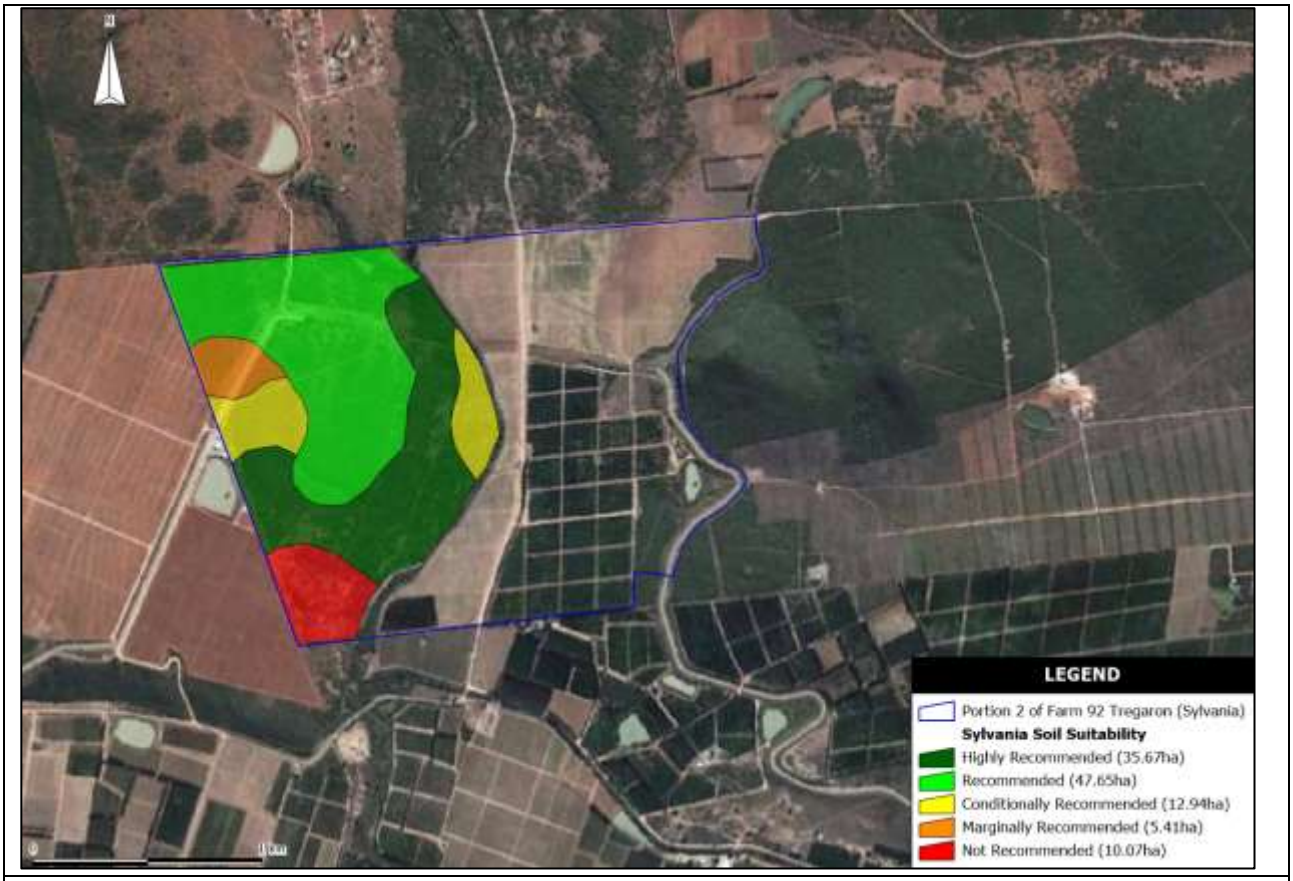
Table 9.2. Summary of soil potentials and suitability classes for the surveyed area.

Soil Potential & Suitability Class	General description of soils	Soil types
7-8 Highly recommended	This potential group is characterized by the occurrence of the Oakleaf soil form. It comprises of a topsoil horizon with a clay content of between 10 and 15% and a B horizon with a clay content of between 15 and 20%. The A and B horizon is suitable for the production of perennial crops. The effective depth of these soils are between 80cm and 1m. No limiting factors occur.	Oakleaf
6-7 Recommended	This potential group is characterized by the occurrence of the Etosha soil form. It comprises of a topsoil horizon with a clay content of between 10 and 15% and a B horizon with a clay content of between 15 and 20%. The A and B horizon is suitable for the production of perennial crops. The C horizon is characterized by a soft carbonate layer from a depth of 60cm. This horizon must not be brought to the surface during soil preparation as this will hinder root development.	Etosha
5-6 Conditionally Recommended	This potential group is characterized by the occurrence of the Gamoep and Dundee soil forms. In the case of the Gamoep soil form it comprises of a topsoil horizon with a clay content of between 10 and 15% and a B horizon with a clay content of between 15 and 20%. The A and B horizon is suitable for the production of perennial crops. The C horizon is characterized by a hard carbonate layer from a depth of 60-80cm which is limiting. This layer should be broken up but not brought to the soil surface. In the case of the Dundee soil form the soil is characterised by the occurrence of varying layers of sand and clay which has been deposited over time. These soil have a limiting factor varying from leach conditions to soil hydraulic variation.	Gamoep,Dundee
4-5 Marginally Recommended	This potential group is characterized by the occurrence of the Sepane soil form. It comprises of a topsoil horizon with a clay content of between 10 and 15% and a B horizon with a clay content of between 30 and 35%. The B horizon contains a Pedocutanic layer that will hinder root development due to the high clay content and coarse blocky structure. This clay layer is limiting with regards to root development and ridges, the correct rootstock and drainage will need to be used to make this area suitable for the production of citrus.	Sepane
3-4 Not Recommended	This potential group is characterized by the occurrence of the Coega soil form. The Coega soil form is characterized by a soft carbonate rich layer from a depth of 30cm. This carbonate layer is limiting to root growth and should not be disturbed. It is recommended not to establish this area with citrus due to the limiting carbonate layer which will fix any micro elements and cause a fluctuation in the soil pH.	Coega

Table 9.3. Suitability summary per class.

Suitability Class	Area (ha)	Area (%)
Highly recommended	35.67	31.92
Recommended	47.65	42.65
Conditionally Recommended	12.94	11.57
Marginally Recommended	5.41	4.84
Not Recommended	10.07	9.02

The majority of the soils (86.14%) in the surveyed area are highly recommended, recommended and conditionally recommended. The areas classified as marginally recommended (4.84%) needs some degree of management and inputs to make it suitable for the cultivation of citrus under irrigation. The area not suitable for the cultivation of citrus due to free lime conditions occurring from 30cm, estimates to 9.02 %. Map 9.4 below indicates the suitability of the soils found at the site, based on the above tables. The soil limitations are covered in brief detail in section 9.5 below.



Map 9.4: Soil Suitability Map of Sylvania

9.5. SOIL LIMITATIONS

The soils described above have been grouped into suitability classes for the cultivation of citrus, based on the limitations present within each map unit. The limitations are described below.

9.5.1. Free Lime

Free lime in the soil as in the case of Coega soil form leads to an increase in the soil pH. This increase may lead to lowered nutrient availability to pH sensitive crops. Elemental deficiencies such as phosphorous, zinc, copper and iron may occur in these crops, which will greatly hamper crop performance. In some cases the free lime conditions may also be associated with salinity problems. For this reason these soils need to be analysed chemically and ameliorated accordingly.

9.5.2. Impermeable clay layers

The impermeable clay layer that occurs in the Sepane soil form from a depth of 20cm is characterized by a strong block structure with a clay content of 40-50%. This horizon has a very negative impact on water penetration lower down in the profile as well as root development due to its strong structure. Due to the layer occurring from a depth of 20cm there will not be enough topsoil to ridge and form a proper soil volume for root development.

9.6. AMELIORATION AND SOIL PREPARATION

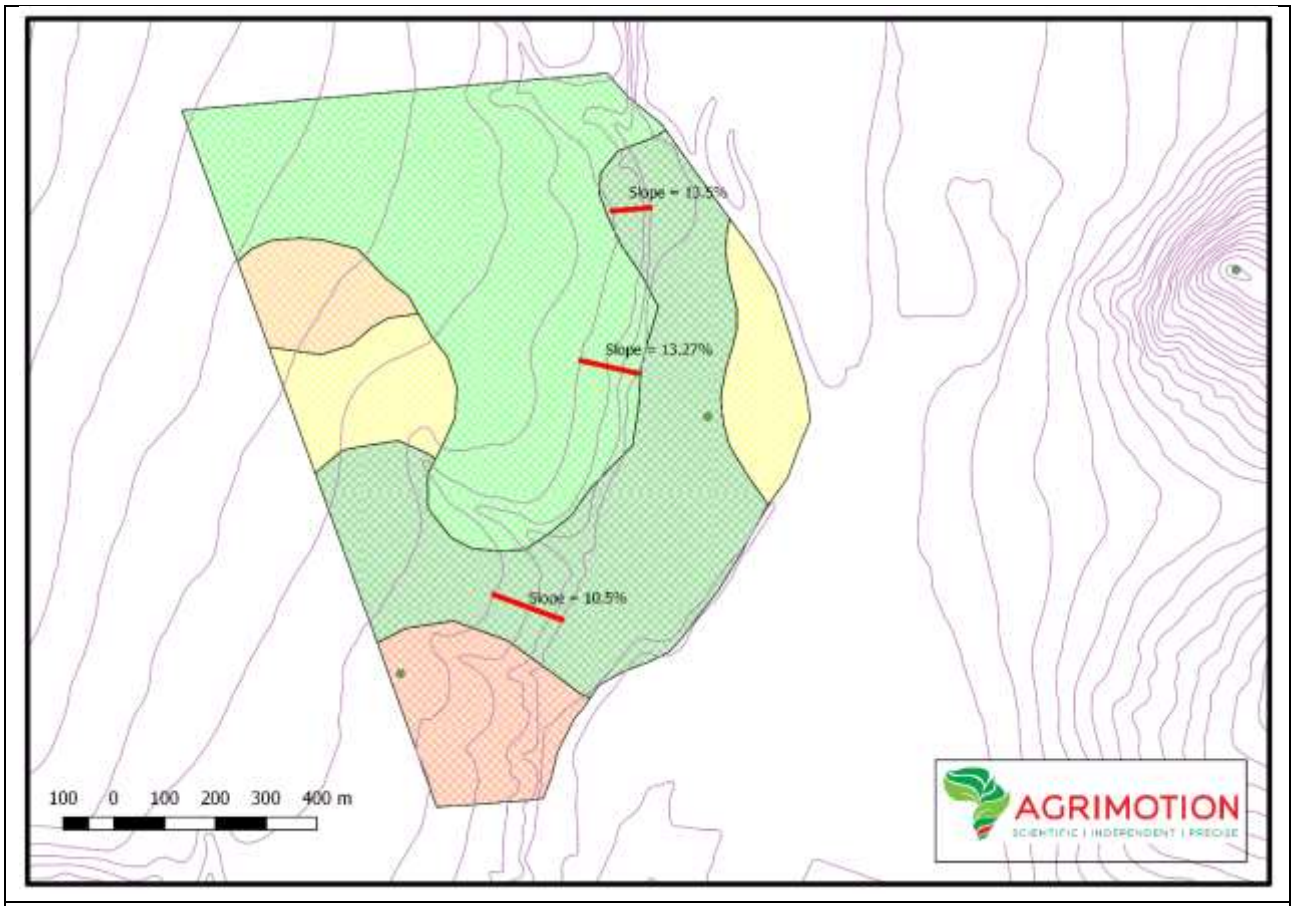
The soil amelioration practices that would be required to a greater or lesser degree at the surveyed area are as follows:

- Deep soil tillage to:
  - Loosen the soil at depth with a **rip action** (only one direction) to improve root penetration and water infiltration and drainage.
  - **Plough** action in the soils that contain no limiting layers and a shallow plough action on the soils with limiting layers to limit the risk of displacement of any free lime from the subsoil to the surface.
- Drainage to reduce the risk of salinification in soils with poor drainage.
- Ridging to increase the root able volume of soil.
- Amelioration through addition of fertilizers as determined from a soil analysis.

These recommendations are not final and will be refined according to the results of a detailed soil survey.

9.7. TOPOGRAPHY

Five (5) meter contours have been used to analyse the area in terms of slope. Three areas have been identified which have the steepest slope over the area of interest as seen in Map 9.5 below. The slopes are in the range of 10 – 13.5 %. The rest of the area has a slope which is more gradual and fall below 10%.



Map 9.5: Slope assessment of the area under assessment

Slopes that are greater than 10% are likely to have a higher risk of erosion if cleared of vegetation and developed for the commercial production of citrus. Therefore, additional erosion protection measures will be required in these areas. Mitigation measures proposed include ridging as well as encouraging the growth of cover crops to ensure that soil erosion due to runoff water is reduced.

9.8. CONCLUSION

The findings of a reconnaissance soil survey covering the 111.74 ha of Sylvania are discussed above. The conclusion is that 96.26ha (86.14 %)) of the land is well suited for the cultivation of citrus. A portion of 5.41ha (4.84 %) is marginally suited for the cultivation of citrus and 10.07ha (9.02 %) is not recommended for the cultivation of citrus. The slope has been analysed over the area and the steepest falling in the range between 10 and 13.5%. Appropriate amelioration and erosion protection measures must be implemented as outlined above.

Further steps in the proposed cultivation of the land would entail a detailed soil classification and sampling of the more suitable areas. Detailed soil amelioration methods can be determined according to the findings of the survey and analyses. The incorrect preparation of the soils may render the land less suitable for cultivation of citrus and thus detailed planning prior to breaking ground is recommended.

9.9. REFERENCES

Soil Classification Working Group. 1991. Soil Classification: A Taxonomic System for South Africa. Mem. Natural Agric. Resources for S.A. No. 15.