Ife Journal of Agriculture, 2023, Volume 35, Number 2

SUITABILITY ASSESSMENT OF SOILS IN IFE AREA (Southwestern Nigeria) FOR COFFEE ROBUSTA (*Coffea canephora Pierre ex A. Froehner*) PRODUCTION

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ABSTRACT

Land suitability evaluation is imperative to identify appropriate land use for effective productivity. This also helps to ascertain the constraints and opportunities for land use and guides decision-makers in their plans. The objective of this study was to assess the suitability of the soils of the study area for coffee production. A parametric model of a suitability assessment and geographical information system was used for the evaluation exercise. Five soil profile pits were established on a toposequence (upper, middle and lower slope), and soil samples taken from pedogenic horizons were described morphologically on the field; physically and chemically in the laboratory following standard procedures. The results of the study showed that the soils were generally well-drained and deep with no restrictions. Sand content in the surface horizons ranged from 62 to 82%, clay from 8 to 20% and silt from 7 to 14%. The pH was low (4.4 to 5.9), while *organic carbon content ranged from 0.66 to 1.64. Environmental factors and fertility status affecting coffee growth and productivity were moderate. Currently, the land is moderately suitable for coffee robusta production. However, the result of the potential productivity index revealed that the land would be highly suitable if properly managed through the application of appropriate fertilizer.*

Keywords: ***land suitability, coffee production, soil profile, geographical information systems, Ife area.***

INTRODUCTION

United Nations, (2013) projected that the global population will reach 9.6 billion people by 2050 and this will create global challenges among which achieving food security, lowering the risk of climate change by reducing the net release of greenhouse gases into the atmosphere and meeting the increasing demand for food will be critical. To mitigate these challenges, a policy framework needs to be developed in which optimal and sustainability of crop production systems become central (Ajayi *et al*., 2021). Cash crop production can play essential roles by delivering multiple services in line with optimal and sustainability principles. Coffee is one of the most essential cash crops in the world. Its importance cannot be overstressed. It is the world's favourite non-alcoholic beverage and one of the most traded commodities after oil. It creates a source of income for farmers, job opportunities for millions of people, foreign exchange earners and industrial raw material producers. Osorio (2002) reported that around 125 million people depend on coffee for their livelihood. Arabica coffee (*Coffea arabica* L.) and robusta coffee (*Coffea canephora* Pierre ex A.Froehner) are the two main species used in the production of coffee. Coffee arabica is usually cultivated in highland tropical and sub-tropical areas, performs best at higher altitudes and has lower caffeine content while the higher-yielding robusta can be grown at sea level (lowland areas) and is generally used in instant coffee and in stronger roasts (CRIN Annual report, 2009).

Although coffee remains a big revenue spinner in the world market, Nigeria's production has fallen to less than 60,000 metric tons in 2020 (The Nation, 2021). Nigeria was ranked 13th among coffee producers in Africa and 41st in the world, producing just about 40,000 of 60 kg bags, 2, 400 metric tons, and 5,291,000 pounds (Szenthe, 2019). To make the production of coffee sustainable, attention should be paid to improving the quality of coffee by engaging in sustainable and environmentally friendly cultivation practices, which ultimately can yield higher returns.

It is essential to identify appropriate areas for agricultural practices in order to improve crop production, especially coffee. Through this, land can be apportioned in terms of suitability for a specific purpose to facilitate for effective land use management and planning systems. Land evaluation is the process of assessing the possible uses of land for agriculture, industry, engineering, conservation, forestry and recreation purposes. It is the assessment of a specific type of land utilization such as extensive grazing, rainfed farming, irrigation and agriculture (Oluwatosin, 2005).

Currently, geographical information systems (GIS) have been found beneficial in achieving the task of land suitability assessment (LSA) (Anagnostopoulos *et al*., 2010). Brail and Klosterman (2001) also reported that one of the most beneficial uses of GIS for planning and management is land use suitability mapping and analysis. Geographical information systems is a computer application capable of creating, storing, manipulating, examining and envisaging geographic information (Goodchild, 2000).

Suitability analysis of land based on a GIS that integrates the preferences of the decision-makers could go a long way in proving sustainable solutions in recognizing appropriate areas for better productivity (Malczewski, 2006). Geographical information systems include scientific tools that enable the integration of data from different sources into a centralized database from which the data are modelled and analyzed. GIS-based tools and processes address the challenges of suitability analysis based on the collection, processing and analysis of spatial data. The GIS approach to LSA is based on multi-criteria rankings and weights assigned to variables that affect coffee production (Frankline and Charles, 2016).

Soil information gathered by systematic identification, grouping and delineation of various soils is necessary when good interpretations of land use potential are to be made (Balthaza *et al.*, 2003). A good data bank on soil properties and related site characteristics is essential to advise both current and potential land users on how to use the land in the best possible way. There is limited information on soil suitability for coffee production, hence this research. The objective of this study was to evaluate the soils in Ife Area for coffee production, using the GIS and parametric approaches.

MATERIALS AND METHODS

The study area

The study was carried out at the Teaching and Research Farm of the Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria. The area is located between latitudes 7º 32’ and 7º 33’N and longitudes 4º 32’ and 4º 40’E. The soils investigated are underlain by coarse-grained granite gneiss and were mapped as belonging to Iwo Association (Smyth and Montgomery, 1962). The climate of the area is tropical with wet and dry seasons. Rainfall is bimodal with mean annual rainfall of 1502 mm and a mean annual air temperature of 29ºC. The area also records the following average monthly data: humidity is 79.56% and wind speed is 3.63 m/s (NASA, 2019). The native vegetation of the study area was formerly rainforest characterized by tall, big trees and thick shrubs. However, as a result of human activities, the vegetation is presently a mosaic of farmlands and secondary forest regrowth.

Field methods

Selection of the study area was done using the existing soil information on southwestern Nigeria soils coupled with reconnaissance field observation. A total number of five profile pits were established along the toposequence at different physiographic positions (upper, middle and lower slopes) in the study area and described following the FAO/UNESCO (2006) guidelines for soil profile description. The morphological properties of the profiles were described in the field. Global Positioning System (GPS) was used to determine the coordinates of each profile pit point (Figure 1a) and the slope was determined (Figure 1b) using inverse distance weighing (IDW) method. Soil samples were collected from the identified genetic horizons and taken to the laboratory for processing and analysis.

Soil analyses

The soils were analyzed for the bulk density by core method (Blake and Hartge, 1986) while the particle size distribution analysis was carried out using the Bouyoucos hydrometer (1965) method. Soil chemical properties were analyzed for soil pH both in water and 1.0 N KCl (Thomas, 1996). Soil organic carbon was determined by the Walkley-Black (1934) method, available phosphorus by Bray and Kurtz (1945), total nitrogen by the Kjeldahl method (Bremner, 1996), exchangeable cations by Thomas (1982); Mg and Ca were determined by AAS and K and Na by flame photometer. Cation exchange capacity by 1.0 N ammonium acetate (NH_4OAc) at pH 7 (Sumner and Miller, 1996).

Land suitability evaluation

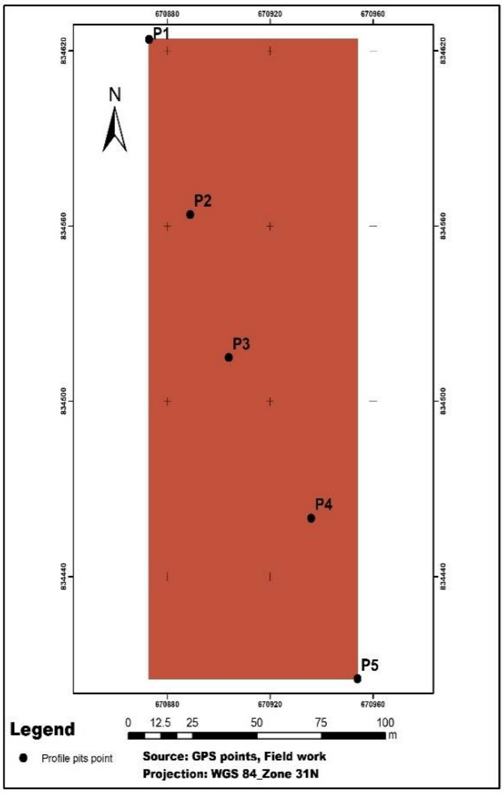
Geographical Information systems and parametric approaches were used for the assessment of land suitability for coffee production. The parametric evaluation method proposed by Sys *et al.* (1993) was employed using soil and land characteristics. These characteristics include climatic factors, topography, wetness, physical characteristics and fertility (Table 1). Pedons were placed in suitability classes by matching their land characteristics with the agronomic requirements of coffee. Each characteristic was rated (usually ranging from 0 to 100) as shown in Table 2. If any property is highly suitable, a rating of 100 was assigned and if not suitable, a minimal rating was assigned to that factor. The index of productivity (IP) (actual and potential) was calculated according to the formula:

$$IP = A \times \sqrt{((B/100) \times (C/100) \times \ldots \times (F/100))}.$$

Where A is the overall lowest characteristic rating and B, C, D….F are the lowest characteristic ratings of each land quality group (Udoh *et al.*, 2006).

Five land quality groups were used for this study as reported by (Ogunkunle, 1993) and only a member of each of the five land quality groups was used in the calculation because there is a strong correlation among members of the same group.

For the GIS approach, the procedure employed was as described by (Kappo *et al.*, 2014). Respective coordinates (latitude and longitude) of each profile pit established on the field were recorded using a global positioning system (GPS) receiver. Plate 1 shows the satellite imagery of the study area. The results of the soil analyses were entered into the database designed and imported into the GIS environment using ArcGIS software. Interpolation techniques for the spatial distribution of soil physical and chemical properties such as bulk density, available phosphorus, soil pH and organic carbon were performed using the inverse distance weighting (IDW) method. The image was checked to conform to UTM Zone 31N of WGS 1984.



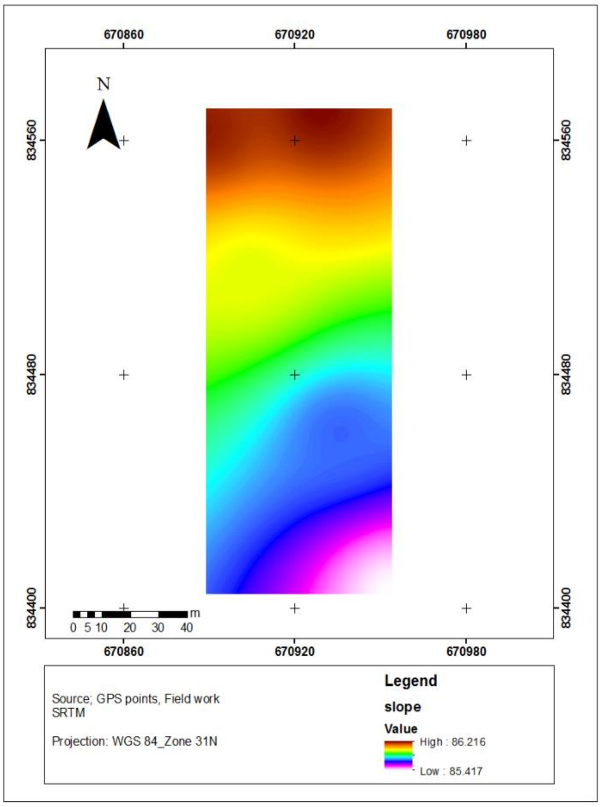


Figure 1a: Map showing the profile pits points study area

Figure 1b: Map showing slope of the

Plate 1: Google Earth imagery of the study area.

RESULT AND DISCUSSION

Soils morphological characteristics

The soil colour of pedon 1 ranged from brown (10YR 5/3 moist) at the soil surface to reddish yellow (5YR 6/8) at the sub-soil. Soil's colour became lighter with depth. The soil texture was silt loam at the surface and sandy clay loam to silty clay loam at the subsoil. Ogban, (2017) reported that soil texture influences soil permeability and hence soil moisture redistribution and water-holding capacity. The soils were well-drained, deep and had no laterite or ironstone within the profile depth. Consistency is friable to firm (moist), slightly sticky and slightly plastic (wet) with a sub-angular blocky structure. The soils had moderate medium crumb on the surface coming down to moderate medium sub-angular blocky structure in the subsoil with diffuse and wavy horizon boundaries.

Pedon 2 was located at the upper slope to the middle position on the toposequense. Soil colour ranged from dark brown (7.5 YR 3/2 moist) at the top and became reddish yellow (7.5 YR 6/8 moist) at the sub-soil. Dengiz *et al*. (2012) reported that variation observed in colour could be related to differences in the organic matter, moisture condition, carbonate accumulation and redoximorphic features of the soils. Change in colour could also be attributed to variations in the topographical positions of the soil profile pits and drainage conditions of the soils (Gerrard 1981). The soils were well-drained, friable consistence with moderate crumb structure. Very fine and very few coarse roots were present.

Pedon 3 occupied the middle slope on the toposequence. The soils were deep and well-drained. The soils had very dark grey colour (7.5 YR 3/1) to red (2.5 YR 5/6) with weak fine crumb on the surface coming down to moderate medium sub-angular blocky structure in the subsoil. Very few very fine and coarse roots occurred frequently in the pedon.

The soil colour of pedon 4 ranged from dark brown (7.5 YR 3/2) at the surface to red (2.5 YR 5/8) at the subsoil. The soils had a fine weak crumb on the surface to a moderate medium crumb at the subsurface, very fine, few medium roots were common. The soils had a sandy loam texture at the surface and gravelly sandy clay at the subsoils. The soils had a fine weak crumb on the surface coming down to moderate medium crumb at the subsurface, very fine, and few medium roots are common.

Pedon 5 was located at the lower slope on the toposequence. The soil was poorly drained but very deep. The colour varied from dark brown (7.5 YR 3/2) at the surface to reddish yellow (7.5 YR 6/6) at the subsoil. The soils had a gravelly sandy clay loam texture at the surface and slightly gravelly sandy clay at the subsoil. Structural aggregate was moderate, very few fine roots are common. On the soil surface, the moist consistency was very friable while the wet consistency is non-sticky, and non-plastic. At subsoil, the soils were friable, sticky and plastic respectively.

Soils physical and chemical characteristics

The particle size distribution analysis results revealed that sand is the dominant fraction in all the pedons. Sand content generally decreased while clay increased, with increasing depth. The increase in clay content with depth might indicate the occurrence of eluviation and illuviation processes or simply translocation within the pedons (Buol *et al*., 2003). Sand content in the surface horizons ranged from 62 to 82%, while in the subsurface, it ranged from 32 to 62%. Information on soil texture is important in land suitability evaluation, it determines soil's retentive capacity for nutrients and water, necessary for healthy plant growth (Halder, 2013). The texture of the surface horizons varied from sandy clay loam (SCL) to sandy loam while subsurface horizons varied from SCL to clay in all the pedons. The clay content in the surface horizons ranged from 8 to 20%, while in the subsurface, it ranged from 24 to 52%. The silt content which has the least value ranged from 7 to 14% in the surface horizons while in the subsurface, it ranged from 8 to 18%. Bulk density (BD) values of the studied soils ranged from 1.13 to 1.58 g/cm^3 at the surface horizons (Figure 2). Generally, sub-soil had higher values of bulk density than surface soils probably due to compaction arising from trampling and the overlying weight of surface soil. The values are below 1.85 g/cm^3, a value considered very high by

Soil Survey Staff (2006) to impede root penetration. Thus, the soils in the study area will enhance water movement, aeration and plant root proliferation.

In the surface horizons, the pH ranged from strong to very strong acid 4.4 to 5.9 and 3.9 to 5.3 in water and 1 M KCl solution, respectively. In the sub-surface, the value ranged from 5.0 to 5.6 and 3.6 to 5.1 in water and 1M KCl solution, respectively. Perfect Daily Grind, (2019) stated that a coffee plant requires an optimum pH level, which is between 4.9-5.6. The plant is better able to absorb nutrients at these levels, resulting in more coffee cherries and fewer pest and disease-related problems. The pH value of the studied soils is presented in Figure 3.

Coffee demand for nutrients is high. It mines substantial quantities of nutrients from the soil in the form of coffee cherries, others may be lost through erosion or leaching. Tiemann *et al*. (2018) estimated that major nutrients removed in one ton of coffee green beans per ha from the field would require 33 kg N, 2.3 kg P, 36 kg K, 2.4 kg Mg and 3.4 kg Ca. In the surface horizons, the value of organic carbon (OC) ranged from 0.66 to 1.64 (Figure 4). The incorporation of organic and inorganic materials should be engaged for sustainable coffee production.

One of the essential macronutrients in coffee production is calcium (Ca). Calcium is involved in several physiological processes that influence crop productivity, growth, development and stress response. Ramírez-Builes *et al*. (2020) concluded that Ca is the third most demanded nutrient in coffee cherries. The values for the Ca content at the surface horizons ranged from 1.22 to 3.17 cmol/kg (Figure 5). The values were above the critical value of 0.9 cmol/kg required for optimal coffee production (Egbe *et al*., 1989). Therefore, the soil does not require the application of fertilizers containing an appreciable quantity of Ca.

Barbara (2001) reported that magnesium (Mg) is important for the formation of proteins, sugars, fats and oil. It is a component of chlorophyll, regulates the uptake of other nutrients, and is a phosphorus carrier. As Mg is important in green plants as part of chlorophyll and an activator of many plant enzymes, its low content could affect the yield of coffee directly (Cambroy, 1992). Magnesium contents of the studied soils at the soil surface varied from 0.37 to 1.02 cmol/kg (Figure 6). The values were below the critical level of 2.0 cmol/kg for optimum coffee production (Egbe *et al*., 1989).

Engels *et al*. (2012) stated that potassium (K) is required for the majority of vital processes in plants' life cycle. Coffee requires K greatly during the development of the berries and is at the maximum during ripening. The peak in the rate of K uptake was observed immediately after bloom, prior to fruit ripening, and after harvest (Mitchell, 1988). Molin *et al*. (2010) and Melke and Ittana (2015) reported that K contributes to beans' quality and quantity. Potassium contents of the surface horizons are represented in Figure 7 and the value ranged from 0.06 to 0.15 cmol/kg. Egbe *et al*., (1989) stated that 0.40 cmol/kg is the critical level ideal for coffee production. Thus, supplying K-based fertilizer would be necessary for the studied soils for optimum production.

Phosphorus (P) is also an important macronutrient in coffee production which affects the tree's growth and beans' yield. It is essential for the root system to grow from the young to the fruit-bearing stage (Wintgens, 2004). The P contents at the surface soils varied from 12.34 to 34.50 ppm (Figure 8). The values are above the critical level of 6 ppm. Therefore, the addition of P-based fertilizer to the soils would not be necessary.

Suitability evaluation

Climatic characteristics of the study area

Environmental factors affecting the growth and productivity of coffee are climatic characteristics such as rainfall, temperature, relative humidity; intensity of sunshine, topography, wind and soil type.

Rainfall, temperature and relative humidity

Rainfall condition is of bigger impact in determining crop productivity for agriculture and rainfall interact together. Thus, to improve crop yield, it is necessary to know the average rainfall of the area that should be well distributed over a year in order to have a good effect on crop yield (Tenkap and Balogun, 2020). For C. *robusta* growth, Descroix and Snoeck (2009) reported that annual rainfall of 2000 – 2500 mm is favourable and that rainfall below 1,200 mm can lead to poor output. Similarly, when rainfall surpasses 3000 mm, leaf diseases from fungal infection increase more easily. On the basis of the annual rainfall of the study area (1502 mm), the suitability class falls under S2 and is rated 85 % for all the pedons (Table 2). The mean annual air temperature and relative humidity of the study area are 29°C and 79.56%, respectively. The mean annual air temperature and relative humidity of the study area scored 100% and fall under the suitability class of S1. For C. *robusta*, the optimal annual mean temperature range between 22 and 30°C. Therefore, it can tolerate slightly higher temperatures than *Arabica coffee*. High temperatures above 30°C during blossoming coupled with a lengthy dry season may cause the abortion of flowers. Descroix and Snoeck, (2009) reported that the optimum relative humidity for C. *robusta* is 70% to 75% and for C. *arabica* it is around 60%. C. *robusta* grows well under high air humidity conditions approaching saturation.

Shade, wind and soil type

Natural or artificial shade is provided to coffee plants in cultivation to recreate their original forest environment, although sunlight-tolerant varieties have been developed for better productivity. Nevertheless, shade is still beneficial, particularly to lessen the consequences of high and low temperatures (Descroix and Snoeck, 2009). Strong wind is injurious to the growth of coffee as it may break the branches of coffee trees. It also increases evapotranspiration as a result of which it creates water stress in the trees (Demel, 1999). The predominant annual wind direction of the study area is 221.87**°.** Descroix and Snoeck (2009) also stated that a soil depth of at least 2 meters is required for taproot growth and development of coffee. The studied soils were deep and well-drained. Pedon 1 was 148 cm deep, pedon 2 was deeper than 200 cm, pedon 3 was about 186 cm deep while pedons 4 and 5 were 127 cm and 190 cm deep, respectively. Fertile soil is an important factor that crops depend on. Vidhaya Trelos-Ges (2010) reported that soils suitable for coffee production should be moderate to highly fertile and well-drained with a soil depth of at least 80 cm. This will allow root proliferation by offering a larger volume of soil which contains more water and nutrients around the coffee trees.

Topography/slope, soil drainage, structure and texture

According to Van Asselen and Verburg (2012), slope is a key factor in land management for agricultural practices and it is used to assess the performance and suitability of land. Considering the topography of the study area, all the pedons were highly suitable and scored 100 % (Table 1). Steep slopes with problems of erosion and areas prone to flooding should be avoided. Tenkap and Balogun, (2020) reported that in areas where the slope is steep, it is difficult to manage land, as it is more time-consuming and incurs higher agricultural costs. The soils were well-drained except pedon 5 which was moderately suitable and scored 85 %. Soil structure that allows good drainage is an essential requirement since water logging reduces crop yield and even leads to the death of coffee trees. Generally, heavy clay soils are not suitable for coffee production as they have poor drainage and make root penetration and growth problematic or impossible. One of the most important properties of soil that determines the availability of water and nutrient to plants is texture. Changes in soil texture with depth can have a great impact on root penetration. Sand, silt and clay generally make up the soil texture classes and refer to the relative sizes of the soil particles (Tenkap and Balogun, 2020). When texture was taken into consideration, only pedon 1 was rated 100 % (S1), others were rated 85 % (S2) (Table 1). The soil texture varied from sandy clay loam to sandy loam. In terms of fertility characteristics, base saturation was rated 100 %, organic carbon 85 % for all the pedons and CEC was rated 60 % (S3).

Aggregate suitability evaluation of the soils

Suitability evaluation of the soils was carried out following Sys *et al.* (1993) method of land evaluation. The pedons were placed in suitability classes by matching their characteristics with the land use requirements for coffee (Table 1). The indices of current and potential suitability were computed using square root parametric method of land evaluation (Udoh *et al.*, 2006). The result of the actual/current suitability rating showed that pedons 1, 2, 3 and 4 were moderately suitable while pedon 5 was marginally suitable (Table 2). The major land characteristics limiting the cultivation of this crop are soil fertility (OC, Mg, and K). Potentially, all the pedons are highly suitable for coffee production. This implies that if the soil is well managed through proper fertilizer management, the land would be highly suitable for coffee production.

CONCLUSION AND RECOMMENDATION

Overall, the nutrient status of the studied soils was low. The soil OC, Mg, and K contents were below the critical levels. The low level of these nutrients was the major constraint on the soils. Hence, optimum coffee production could not be ascertained on the soils without appropriate fertilizer application. It is, therefore, necessary that the combined application of organic and inorganic appropriate fertilizers should be encouraged to enhance soil fertility and sustainability of these soil resources

Table 1: Land suitability requirements for coffee *robusta* production

Land qualities	Suitability classes				
	S1(100%)	S2 (85%)	S3 (60%)	N1 (40%)	N2 (20%)
Climate (c)					
Annual rainfall (mm)	1,600-2,400	1,400-2,400	>1,200	__	Any
Mean annual temperature (°C)	>22	>20	>18	__	<18
Relative humidity (%)	45-80	35-90	30-100	__	Any
Length of dry season (months)	1-2	2-3	3-4	__	>4
Topography (t)					
Slope (%)	<8	<16	<30	<50	Any
Wetness (w)					
Drainage	Well drained	Moderate	Imperfect	Poor	Very poor
Flooding	No	No	Slight	Any	Slight
Physical soil characteristics(s)					
Soil depth (cm)	>150	>100	>50	>50	Any
Texture/structure	C+60s to SCL	C+60s to SL	C+60s to LFS	C+60s to LFS	Cm to Cs
Coarse fragments (Vol. %)	<15	<35	<55	<55	>55
Fertility characteristic (f)					
Organic matter (% C, 0-15cm)	>0.8	Any	__	___	___
Base saturation (%)	>20	Any	__	__	__
CEC (Meq/ 100 g soil)	>16	__	__	__	__

C+60s to SCL = Very fine clay blocky structure to sandy clay loam, C+60s to SL = Very fine clay blocky structure to sandy loam, C+60s to LFS = Very fine clay blocky structure to loamy fine sand, Cm to Cs = Massive clay to sandy clay. S1 = highly suitable, S2 = moderately suitable, S3 = marginally suitable, N1 = presently not suitable, N2 = permanently not suitable.

Source: Modified from Sys *et al.* (1993)

Table 2: Suitability class scores of the soils for coffee *robusta* production

Land quality		Pedon 1	Pedon 2	Pedon 3	Pedon 4	Pedon 5
Climate (C)	Annual rainfall (mm)	S2(85)	S2(85)	S2(85)	S2(85)	S2(85)
	Mean annual temperatures (°C)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)
	Mean relative humidity (%)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)
Topography (T)	Slope (%)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)
Wetness (W)	Soil drainage	S1(100)	S1(100)	S1(100)	S1(100)	S2(85)
Soil Physical Properties (S)	Texture	S1(100)	S2(85)	S2(85)	S2(85)	S2(85)
	Soil depth (cm)	S2(85)	S1(100)	S1(100)	S2(85)	S1(100)
Fertility (F)	CEC (cmol/kg)	S3(60)	S3(60)	S3(60)	S3(60)	S3(60)
	Soil organic carbon (%)	S2(85)	S2(85)	S2(85)	S2(85)	S2(85)
	Base saturation (%)	S1(100)	S1(100)	S1(100)	S1(100)	S1(100)
Aggregate suitability	**Actual/current suitability class**	**55 (S2)**	**51 (S2)**	**51 (S2)**	**51 (S2)**	**47 (S3)**
	Potential suitability class	**78 (S1)**	**78 (S1)**	**78 (S1)**	**78 (S1)**	**72 (S1)**

Aggregate suitability class scores: S1 = 75-100; S2 =50-74; S3 =25-49; N1 12-24; N2 =0-12

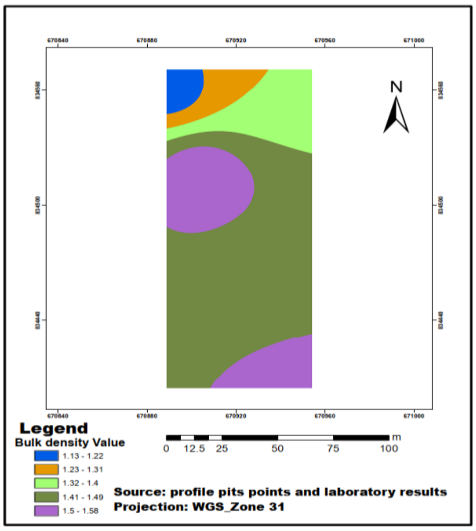


Figure 2: Map showing distribution of BD.

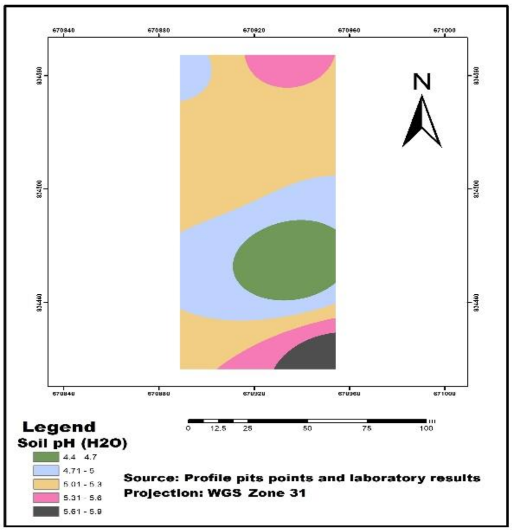


Figure 3: Map showing distribution of soil pH

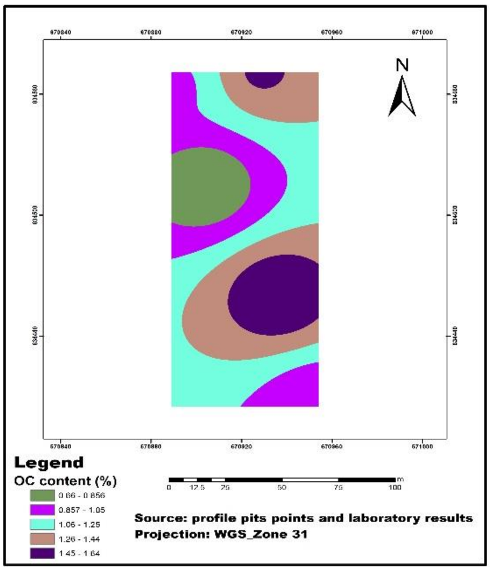


Figure 4: Map showing distribution of (OC).

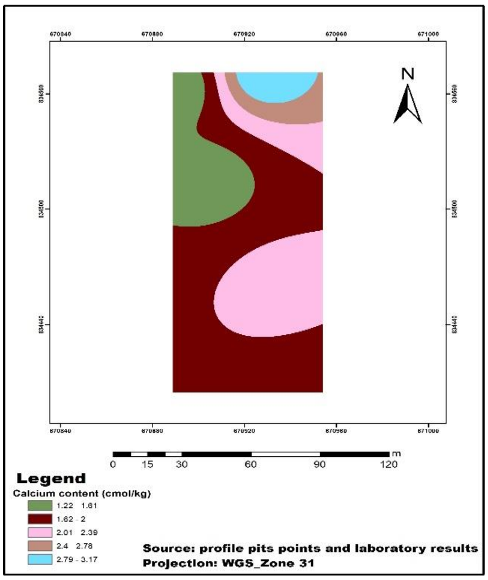


Figure 5: Map showing distribution of Ca content

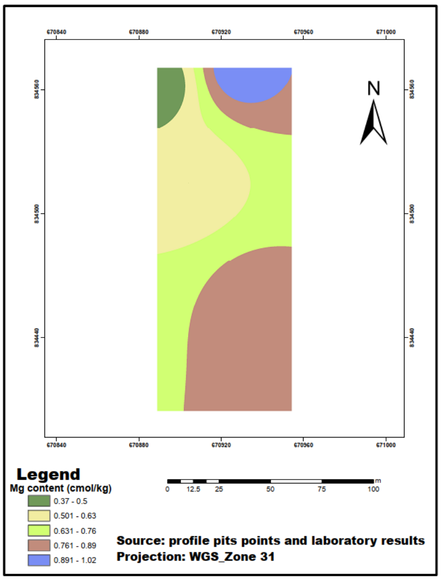


Figure 6: Map showing distribution of Mg content.

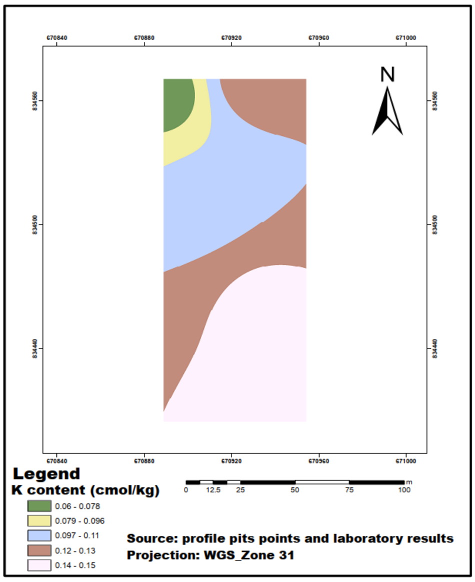


Figure 7: Map showing distribution of K content

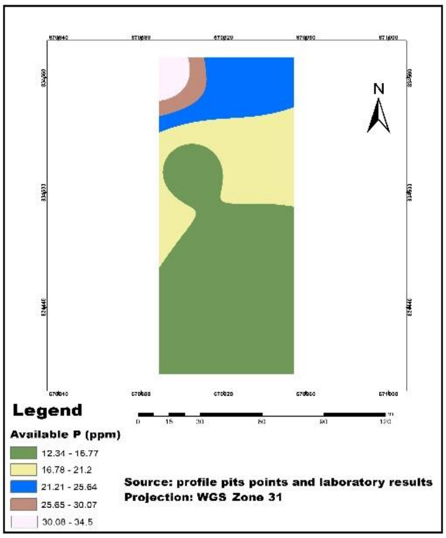


Figure 8: Map showing distribution of P content

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